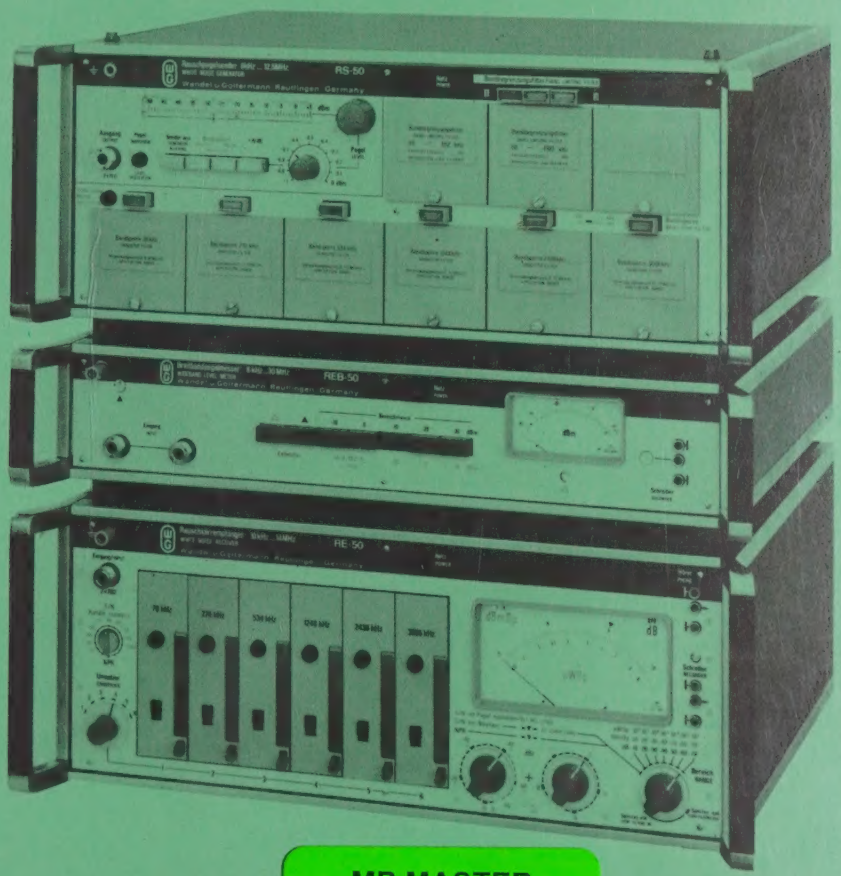
Service Manual



MP MASTER
MA33497

White Noise Measuring Set

RK-50

measures the noise power , the S/N (signal-to-noise ratio) and the NPR (noise power ratio) on frequency division multiplex cable, radio-link and satellite systems

WHITE NOISE MEASURING SET RK-50

measures the noise power, the S/N (signal-to-noise ratio) and the NPR (noise power ratio) on frequency division multiplex cable, radio-link and satellite systems

Service manual 642/643 A...

1.4.77
0.35.4.77 2384

Printed in the
Federal Republic of Germany

Subject to change without notice

Wandel & Goltermann · Reutlingen/Germany

CONTENTS

6. Preliminary remarks to service manual 6-1

6.1. Important precautions for technical safety 6-1
6.1.1. Opening the cabinet 6-1
6.1.2. Fuses 6-1
6.1.3. Repairs, parts substitutions 6-1
6.1.4. Tests after repair or maintenance 6-1
6.2. Abbreviations, symbols and other 6-1
6.2.1. Component designation 6-1
6.2.2. Interconnection between subassemblies 6-1
6.2.3. Abbreviations and symbols 6-2
6.3. How to order replacement parts 6-2
6.4. Employed measuring equipment 6-3

7. Fault localization and repair instructions 7-1

7.1. Simple repair work 7-1
7.2. Stripping the measuring set 7-1
7.2.1. Removing the unit covers 7-1
7.2.2. Removal of knobs 7-1
7.2.3. Removal of printed circuits from the aluminium housing . . 7-1
7.3. Special stripping operations on the RS-50 Generator . . . 7-1
7.3.1. Removal of the front panel 7-1
7.3.2. Removal of the rear cover 7-1
7.3.3. Removal of the mains switch 7-1
7.3.4. Removal of the pushbutton sets 7-2
7.3.5. Removal of single pushbutton 7-2
7.3.6. Removal of the relay cards of the band switch 7-2
7.3.7. Removal of the relay cards of the band stop switch 7-2
7.3.8. Removal of the logic card 7-2
7.4. Special stripping operations on the RE-50 Receiver 7-2
7.4.1. Removal of the front panel 7-2
7.4.2. Removal of the rear cover 7-2
7.4.3. Removal of the mains switch 7-2
7.4.4. Removal of the board unit with the switches S 601, S 602, and S 603 7-3
7.5. Position of the assemblies and test points in the units and plug-ins 7-3
7.6. Fault finding in the RS-50 Noise Generator 7-19
7.6.1. Fault finding plan 7-19
7.6.2. Level diagram 7-23

CONTENTS

7.6.3. Checking the supply voltages 7-23
7.6.4. Testing the band switch 7-23
7.6.5. Testing the band stop switch 7-24
7.6.6. Relay diagram 7-26
7.7. Fault finding on the Band Limiting Filters RSB 7-26
7.8. Fault finding on the Band Stop Filters RSS 7-26
7.9 Fault finding on the RE-50 Noise Receiver 7-26
7.9.1. Checking the supply voltages 7-26
7.9.2. Level diagrams 7-26
7.9.2.1. AF signal path 7-27
7.9.2.2. AF filters 7-27
7.9.2.3. Measuring mode/system attenuator and AF amplifier . . . 7-28
7.9.2.4. From rectifier to meter 7-28
7.9.3. Checking the RF signal path 7-28
7.9.4. Relay diagram 7-29
7.10. Fault finding on the Converter Plug-ins REU 7-29
7.10.1. Checking the amplification of a Converter Plug-in . . . 7-29
7.10.2. Checking the relay circuit 7-30
7.10.3. Fault finding diagram 7-31

8. Checking of important technical specifications 8-1

8.1. Noise Generator RS-50 8-1
8.1.1. Error limits of the output level at 0 dBm 8-1
8.1.2. Error limits of the fine level control 8-1
8.1.3. Error limits of the output level attenuator 8-1
8.1.4. Reflection at output 8-2
8.1.5. Noise band with Band Limiting Filter RSB 8-3
8.1.5.1. Frequency response in the "Flat Area" 8-3
8.1.5.2. Check of the effective band limits 8-3
8.1.5.3. Reduction of the noise power density outside the effective band limits 8-3
8.2. Band Stop Filters RSS 8-3
8.3. Noise Receiver RE-50 with Converter Plug-ins REU . . . 8-4
8.3.1. Attenuation error of the measuring range switch S 603 . . . 8-4
8.3.2. Attenuation error of the reference level switches S 601 and 602 8-4
8.3.3. Attenuation error of the measuring mode/system switch S 501 8-5
8.3.4. Scale error in the range - 5 to + 5 dB 8-5
8.3.5. Amplification and pass curve of the AF filter 8-6
8.3.6. Intrinsic noise 8-6

CONTENTS

8.3.7. Reflection at input 8-7
8.4. Intrinsic NPR of the Measuring Set RE-50 8-7

9. Alignment instructions 9-1

9.1. Noise Generator RS-50 9-1
9.1.1. Adjustment of the supply voltages (P 101, P 102) 9-1
9.1.2. Alignment of the reflection loss at the output of the noise source (C 227) 9-1
9.1.3. Alignment of the noise source level (P 201, P 202, C 211, C 224) 9-2
9.1.4. Alignment operations on the reference path of the Noise Level Generator (C 811) 9-2
9.1.5. Frequency response alignment of the whole unit with noise at minimum amplification (C 424, P 201) . . . 9-3
9.1.5.1. Check at maximum amplification 9-5
9.1.6. Level alignment with noise (P 801) 9-6
9.2. Noise Receiver RE-50 9-6
9.2.1. Adjustment of the supply voltages (P 101, P 102) 9-6
9.2.2. Alignment of the meter indication (P 803, P 807) 9-6
9.2.3. Alignment of board [643-M] rectifier, quasi effective value generator, logarithmer, and indication (P 801..P 809) . 9-7
9.2.4. Calibration of the Noise Receiver (P 802, P 803) 9-8

10. Description of function 10-1

10.1. Noise Generator RS-50 10-1
10.1.1. Noise source (2) 10-1
10.1.2. Band switch (3) 10-1
10.1.3. Adjusting amplifier (4) 10-1
10.1.4. Attenuator 1, driver, and final amplifier (5) 10-2
10.1.5. Stop filter switch (6) 10-2
10.1.6. Logic circuit, level control, attenuators 2, 3, and 4 (7) . . 10-3
10.1.6.1. Manual control 10-3
10.1.6.2. Partial remote control 10-4
10.1.6.3. Complete remote control 10-5
10.1.6.4. Attenuator 2 10-5
10.1.6.5. Attenuator 3 10-5
10.1.6.6. Attenuator 4 10-6
10.1.7. Measuring amplifier and regulator (8) 10-6
10.2. Band Limiting Filter RSB 10-6
10.3. Band Stop Filters RSS 10-8

CONTENTS

10.4.	Noise Receiver RE-50	10-8
10.4.1.	RF pre-attenuator, pre-attenuator control, and distributor (2)	10-8
10.4.2.	Frequency switching (3)	10-8
10.4.3.	AF filter (4)	10-9
10.4.4.	Measuring mode/system attenuator (5)	10-10
10.4.5.	AF amplifier (6)	10-11
10.4.6.	Rectifier, quasi effective value circuit, logarithmer, and indication (8)	10-12
10.5.	Converter Plug-ins REU	10-14
10.5.1.	Prefilter	10-15
10.5.2.	Amplifier I	10-15
10.5.3.	Band-pass filter	10-16
10.5.4.	Amplifier II	10-17
10.5.5.	Modulator	10-17
10.5.6.	Oscillator	10-18
10.5.7.	Function of the Converter Plug-ins in the RE-50 Receiver	10-19

6. PRELIMINARY REMARKS TO SERVICE MANUAL

6. PRELIMINARY REMARKS TO SERVICE MANUAL

6.1. IMPORTANT PRECAUTIONS FOR TECHNICAL SAFETY

This Measuring Setup was dispatched from the factory in a perfectly safe technical condition. In order to maintain this condition and its safe operation, we recommend the following precautions be painstakingly observed.

6.1.1. Opening the Cabinet

When removing panels from the cabinet, or using tools for the demounting of components, it is possible that components at an applied voltage might be touched, or connection points at a voltage might be contacted.

Therefore, before the cabinet is disassembled in any way, the instrument must be disconnected from all voltage sources.

If, however, for calibration, maintenance or repair, it is impossible to remove all voltages before undertaking the task at hand, then only personnel thoroughly familiar with the dangerous aspects of the open instrument should be permitted to work on it.

Capacitors in the equipment can remain charged at their operating voltage, even after all voltage sources have been removed. In consequence, the circuit diagrams should be carefully observed.

6.1.2. Fuses

Only specified fuses may be used.

6.1.3. Repairs, Parts Substitutions

Repairs should be made only by qualified service personnel. Furthermore, special attention must be paid to retaining all design characteristics of the equipment, and no modifications which decrease the safety should be made. Particularly, the leakage paths and air gaps and the separations with insulating materials should not be decreased.

Component parts should be replaced only with original spare parts. Other spare parts are permissible only if the safety features of the equipment are not degraded.

6.1.4. Tests after Repair or Maintenance

Testing the protective ground conductor :

The usual safe condition of the connections and operational capability are tested by visual inspection and by measuring the resistance between the power plug's protective ground connection and the case. This resistance should be $< 0.5\ \Omega$. And during the measurement, the power cable should be wiggled and twisted. Changes in resistance are an indication of damage.

Testing the insulation resistance

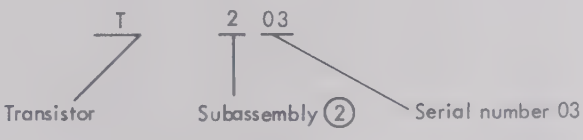
The insulation resistance should be measured at 500 V between the a.c. line connection and the protective ground connection. For this purpose, the equipment's a.c. power switch should be placed in the ON position. The insulation resistance should be $> 2\ M\Omega$.

6.2. ABBREVIATIONS, SYMBOLS AND OTHER

The following sections 6.2.1. to 6.2.4. explain the applied abbreviations, symbols and schematics used in the "Service Handbook" (Service Manual and Appendix including circuit diagrams, layout drawings and component lists).

6.2.1. Component Designation

The various subassemblies are annotated with an individual number, for instance (2) AF filter. Each component located in this subassembly has the number 2 as its first digit. The two subsequent digits define the serial number of the component, for instance resistor 01 would be R 201, capacitor 23, C 223 and so on. The corresponding letter indicates what type of component is involved.

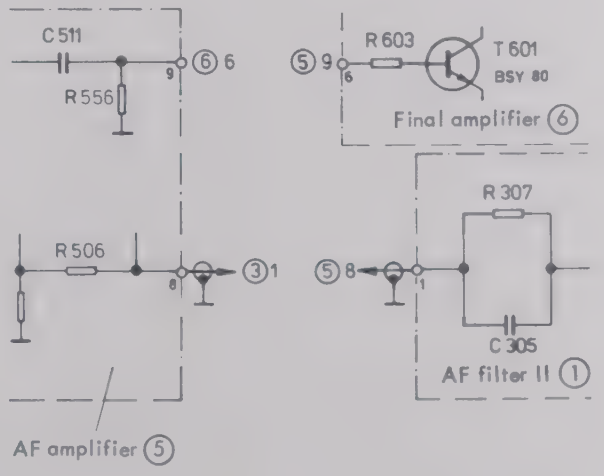


The abbreviations used to designate the components are given in section 6.2.3.

6.2.2. Interconnection between Subassemblies

Since the circuit diagrams are given separately for each subassembly, it is important that all interconnections are shown clearly. The following drawing explains the method used in this manual.

In the sketch below point 9 of module (5) is connected to point 6 of module (6) and a shielded connection from point 1 of module (3) to point 8 of module (5) .



6. PRELIMINARY REMARKS TO SERVICE MANUAL

6.2.3. Abbreviations and Symbols

In order to achieve a greater simplicity, the following abbreviations and symbols have been used in the text and on the circuit diagrams:

Battery	B	
Socket	Bu	
Diode, rectifier	Gl	
Zener diode	Gl	
Varactor diode	Gl	
Light emitting diode (LED)	Gl	
Inductance	L	
Meter	J	
Capacitor	C	
Potentiometer	P	
Quartz crystal	Q	
Relay	Rel	
Relay contact	rel	
Switch	S	
Fuse	Si	
Control lamp	SL	
Transistor, bipolar	T	
Transistor (junction-FET)	T	
Transistor MOS-FET (metal oxid semiconductor-FET)	T	
Integrierte Schaltung	IC, IC	
Transformer	Ü	
Resistor	R	
Thermistor, PTC resistor	R	

Other important abbreviations:

(2)	= subassembly (2) = circuit diagram (2)
642-E	= circuit board E
Pkt. 6	= terminal point 6
TP 303	= test point 303

Abbreviations of connection lead colours

bl	blue	rt	red
bk	barewire	Schirm	screened
br	brown	sw	black
fl	transparent	vio	violet
ge	yellow	ws	white
gn	green		
gr	grey	wsbl	white/blue
rs	pink	wsbr	white/brown

6.3. HOW TO ORDER REPLACEMENT PARTS

The most important information about needed replacement parts is found in the component part lists. Component parts with Bv. or WN numbers are to be ordered from the factory.

When ordering replacement parts it is important to state the order number (BN) as well as the equipment number and the position number of the component part, e.g.

BN 642/No. 72106 B/T 202

Order and equipment numbers are located on the white identification label on the left handle of the White Noise Generator RS-50 and the White Noise Receiver RE-50 (left-looking at front panel). For the Plug-ins, the identification label is on the right side of the plug-ins.

The information pertaining to the ordering of replacement printed-circuit boards is obtained from the circuit diagram. It is made up from a bosed number-letter combination, e.g. 642-H. Thus, the complete information required for ordering is, e.g.

BN 642/No. 72106 B/396-H

6. PRELIMINARY REMARKS TO SERVICE MANUAL

6.4. EMPLOYED MEASURING EQUIPMENT

The measuring devices needed for servicing are listed in the following table. These are just suggested equipments, and equally useful instruments made by other manufacturers can be used.

WHITE NOISE GENERATOR RS-50

Equipment	Suggested model		Mentioned in para.
D.C. multimeter 100 kΩ/V	UM-1	AEG	7.6.1./7.6.2./7.6.3./7.6.4./7.6.5./ 7.6.6.
Digital voltmeter for a.c. and d.c.	7000 A with Option 02	Fair-child	9.1.1./9.1.4.
Level generator	PS-6	W & G	7.6.1./7.6.2./8.1.3./8.1.4.
Selective level meter with test probe	SPM-6 with TK-12	W & G	7.6.1./7.6.2./8.1.3./8.1.4./8.1.5.
Calibrated level meter with test probe and accessories (T piece, Attenuator 19.03 dB, Adaptors)	EPM-1 with TK-10	W & G	8.1.1./8.1.2./9.1.4./9.1.5./9.1.6.
Selective level measuring set	PSM-5	W & G	9.1.2./9.1.3./9.1.4./9.1.5./9.1.5.1.
Indication expander	AZD-1	W & G	9.1.3./9.1.5./9.1.5.1.
Reflection measuring adapter	RFZ-5	W & G	8.1.4./9.1.2.
75 Ω voltage divider	RT-1	W & G	9.1.5./9.1.5.1.
Attenuators 20, 10, 6, 3 dB (Z=75Ω)			9.1.4./9.1.5.
75 Ω termination resistor			9.1.4.
Adapter	RSSA-50	W & G	9.1.2./9.1.5.1.

BAND LIMITING FILTERS RSB

Equipment	Suggested model		Mentioned in para.
White noise generator	RS-50	W & G	8.1.5.
Selective level meter	SPM-6	W & G	8.1.5.

BAND STOP FILTERS RSS

Equipment	Suggested model		Mentioned in para.
Level generator	PS-6	W & G	8.2.
Selective level meter	SPM-6	W & G	8.2.

6. PRELIMINARY REMARKS TO SERVICE MANUAL

WHITE NOISE RECEIVER RE-50

Equipment	Suggested model		Mentioned in para.
D.C. multimeter 100 kΩ/V	UM-1	AEG	7.9.1./7.9.2.4./7.9.4./8.3.5.
Digital voltmeter for a.c. and d.c.	7000 A with Option 02	Fair-child	7.9.2.4./8.3.3./9.2.1./9.2.4.
Digital voltmeter	LM 1420 2	Solartron	9.2.3.
Standard level generator (1 kHz)	PN-27	W & G	9.2.2./9.2.3.
Noise generator	RG-1	W & G	9.2.4.
Level generator	PS-19	W & G	8.3.5.
Level generator	PS-3	W & G	7.9.2.
Level generator	PS-6	W & G	7.9.3./8.3.1./8.3.2 /8.3.3./8.3.4./ 8.3.7.
Selective level meter	SPM-6	W & G	7.9.3./8.3.7.
Calibrated level meter	EPM-1	W & G	9.2.4.
Wideband voltmeter	400 EL	hp	7.9.2./8.3.5.
Level measuring set	PSM-8	W & G	9.2.4
Indication expander	AZD-1060	W & G	9.2.4.
Reflection measuring adapter	RFZ-5	W & G	8.3.7.
Frequency counter	FZ-4	W & G	8.3.5.
Oscilloscope	PM 3240	Philips	7.9.2.4.
75 Ω attenuator	FE-1	W & G	8.3.5.
75 Ω voltage divider	RT-1	W & G	9.2.2.
Power supply unit - 20 V	Konstanter	Gossen	9.2.3.
Power supply unit + 12 V	Konstanter	Gossen	9.2.3.

CONVERTER PLUG-INS REU

Equipment	Suggested model		Mentioned in para.
White noise generator	RS-50	W & G	7.10.1.
White noise receiver	RE-50	W & G	7.10.1.
Calibrated level meter	EPM-1	W & G	7.10.1.
Selective level measuring set with test probe	PS-6/SPM-6 with TK-12	W & G	7.10.3.
Wideband voltmeter	400 EL	hp	7.10.3.
Oscilloscope with test probe 10 : 1	PM 3240 with PM 9350	Philips	7.10.3.
Frequency counter	FZ-4	W & G	7.10.3.
D.C. multimeter 100 kΩ/V	UM-1	AEG	7.10.3.
Power supply unit 25 V =	6224 B	hp	7.10.3.

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

The following sections contain all necessary information for fault finding and localization. The emphasis during fault finding should be on the detection of functional faults and not of tolerance faults, tolerance faults being understood as values outside a guaranteed error limit without any important negative effects on the function of the unit.

Fault finding is carried out with the aid of fault finding diagrams, level diagrams and relay plans.

A further aid to fault finding is the appendix to the Operating and Service Instructions with block diagrams and circuit diagrams, component drawings, and parts lists. Chapter 10 FUNCTIONAL DESCRIPTION provides a description of the circuit diagrams.

In addition, all important views of the units are shown in the following sections and the position of the assemblies and test points are marked in order to simplify fault finding.

For fault finding purposes, it is assumed that the contents of Chapters 4 and 5 of the Operating Instructions are already known.

7.1. SIMPLE REPAIR WORK

Simple repair work such as the replacement of defective pilot lamps or fuses, has already been described in Chapter 5 of the Operating Instructions.

7.2. STRIPPING THE MEASURING SET

Before starting to strip the basic units, the plug-ins (RSB, RSS or REU) are to be removed.

7.2.1. Removing the Unit Covers

The bottom, top, and side covers are fixed with screws on the rear of the units. Each cover can be removed after loosening the two appropriate screws by pulling it to the rear.

7.2.2. Removal of Knobs

The knob cover is removed with a knife. Depending on the type of knob, the clamping cone which holds the knob on the axle is then loosened with a special spanner (fitting spanner for knobs with ring nuts, Order No. W 9) or with a screwdriver. After this the knob can be pulled off the axle. If the clamping cone does not loosen itself then tap lightly on the knob.

7.2.3. Removal of Printed Circuits from the Aluminium Housing

For this purpose, the cover of the appropriate aluminium housing must first be removed. After unsoldering the connecting wires or removal of the AMP plugs the fixing screws of the printed circuit board are removed. The printed circuit can then be lifted out.

The boards 642-B and 642-E in the RS-50 generator are additionally screened with a feathered plate as well as the cover.

7.3. SPECIAL STRIPPING OPERATIONS ON THE RS-50 GENERATOR

7.3.1. Removal of the Front Panel

- Remove the top and bottom covers.
- Remove the knobs and the Versacon (R) universal connector from the generator output (not necessary on some models due to the small dimensions!).
- Remove the printed cover plate after removal of the appropriate screws.
- The front panel is fixed to the unit frame with 9 Phillips-head screws. Before swivelling out the front panel remove the two AMP plugs from the support level 642-U on the fine level switch S 801, disconnect the coaxial cable to the generator output at the Subminax connector st/Bu 702 on attenuator (2) (board 642-K), and remove the cable to the main switch from its clamps.

7.3.2. Removal of the Rear Cover

The rear cover of the RS-50 generator is in two parts. The power supply is mounted on the larger, left section of the rear cover and the smaller section of the cover is used for mounting the remote control socket.

Removal of the larger section of the rear wall is carried out as follows:

- Remove the bottom cover.
- Unscrew the two left clamping screws.
- Remove the printed cover after loosening the appropriate screws.
- The rear cover is fixed to the unit frame with 4 Phillips-head screws.
- Remove the cable to the mains switch (on the front panel) from its clamps and swing out the rear cover with the power supply unit (mains transformer, Board 642-Q).

7.3.3. Removal of the Mains Switch

- Remove the front panel (Section 7.3.1).
- Remove the decorative strip from the

upper cross support of the unit frame (3 counter sunk Phillips-head screws).
- The mains switch is fixed to the cross support with 2 screws.
- The cover over the mains switch contacts can be lifted off with a knife.

7.3.4. Removal of the Pushbutton Sets

- Remove the front panel (Section 7.3.1).
- Unsolder the connections to the appropriate pushbutton set.
- Unscrew the pushbutton set from the front panel (2 counter sunk Phillips-head screws).

7.3.5. Removal of Single Pushbutton

- Remove the front panel (Section 7.3.1).
- Each single pushbutton is fixed to a chassis with 2 Phillips-head screws. After loosening the appropriate screws, the pushbutton is to be pushed into the inside of the unit until the solder contacts are accessible.

7.3.6. Removal of the Relay Cards of the Band Switch

The band switch assembly (3) is mounted in a chassis which is accessible after removal of the rear cover.

- Remove the left section of the rear cover (Section 7.3.2).
- Remove the chassis cover after unscrewing 6 Phillips-head screws.
- Remove the printed circuits with the relays as described in Section 7.2.3.

7.3.7. Removal of the Relay Cards of of the Band Stop Switch

Access to the band stop switch assembly (6) is possible after removal of the bottom cover.

- Remove the bottom cover.
- Remove the chassis cover (14 Phillips-head screws).
- Remove the printed circuits with the relays for band stop switching as described in Section 7.2.3.

7.3.8. Removal of the Logic Card

- Remove the leftside cover.
- Remove the protective cover (6 Phillips-head screws).
- Unscrew the 2 Phillips-head screws with which the connector 642-V (in the vicinity of the front panel) is fixed to the logic card 642-A .
- Remove the left section of the rear cover (Section 7.3.2).
- Remove the two clamping screws on the righthand side of the rear cover.
- Remove the small printed cover (2 screws).
- As the remote control card forms one unit with the righthand section of the rear cover, remove it by unscrewing the 2 Phillips-head screws from the unit frame.
- Unsolder the connections to the logic card.
- Remove the fixing screws for the logic card (4 Phillips-head screws).
- Pull the logic card out towards the rear of the unit.

7.4. SPECIAL STRIPPING OPERATIONS ON THE RE-50 RECEIVER

7.4.1. Removal of the Front Panel

- Remove the rop cover.
- Remove the knobs and the Versacon (R) universal connector from the receiver input (not necessary on some models due to their small dimensions!)
- Remove the printed cover after removing the appropriate screws.
- The front panel is fixed to the unit frame with 8 Phillips-head screws. Before swinging out the front panel the coaxial cable to the receiver input is to be disconnected at the Subminax connector Bu 202/St 225 on the RF pre-attenuator 1 (2) (Board 643-B).

7.4.2. Removal of the Rear Cover

The rear cover of the unit is in two parts. The power supply unit is fixed on the larger, lefthand part of the rear cover and the smaller part carries the AF output I and II and the remote control socket.

Removal of the left section of the rear cover is carried out as follows:

- Remove the top cover.
- Remove the two left clamping screws.
- Remove the printed cover after unscrewing the appropriate screws.
- The rear cover is fixed to the unit frame with 4 Phillips-head screws.
- Before swinging out the rear cover, remove the cable to the mains switch on the front panel.

7.4.3. Removal of the Mains Switch

- Remove the top cover.
- Remove the decorative strip from the upper cross support of the unit frame (3 counter sunk Phillips-head screws).
- The mains switch is fixed to the cross support with 2 screws.
- Remove the cable to the mains switch from the first few clamps and push the mains switch into the unit until it is free.
- The cover over the mains switch contacts can be lifted with a knife.

7.4.4. Removal of the Board Unit with the Switches S 601, S 602, and S 603

The reference level switches S 601 and S 602 and the measuring range switch S 603 are mounted on the printed circuit 643-K. Together with the printed circuits 643-M and 643-D this forms a unit which must be removed for repairs to one of the three boards.

This is done as follows:

- Remove the top bottom and right covers.
- Remove the knobs of switches S 601, S 602, and S 603.
- Unscrew the fixing support marked in Fig. 7-5; to do this remove the 4 Phillips-head screws.
- Loosen the cable clamps at the top center and on the right of the unit.
- Remove the 2 x 10 pole connector from the socket on the power supply board 643-A.
- Loosen the board block by unscrewing 2 Phillips-head screws on each of the upper and lower unit cross supports.
- Lift the board block upwards out of the unit (take care with the switch axles!).
- Unsolder the connections and disconnect the Subminax connectors.

7.5. POSITION OF THE ASSEMBLIES AND TEST POINTS IN THE UNITS AND PLUG-INS

Fig. 7-1 to 7-7 show various views of the units and of the plug-ins of the measuring set RK-50 which are important for stripping and measuring purposes.

When the units or plug-ins are ready for operation, the circuits visible in the aluminium housings on some of the pictures are sealed with covers for screening purposes. During fault finding the covers should be left on the housings as far as possible.

Important alignment components are accessible through holes in the covers.

Units of Series C were used for the photographs.

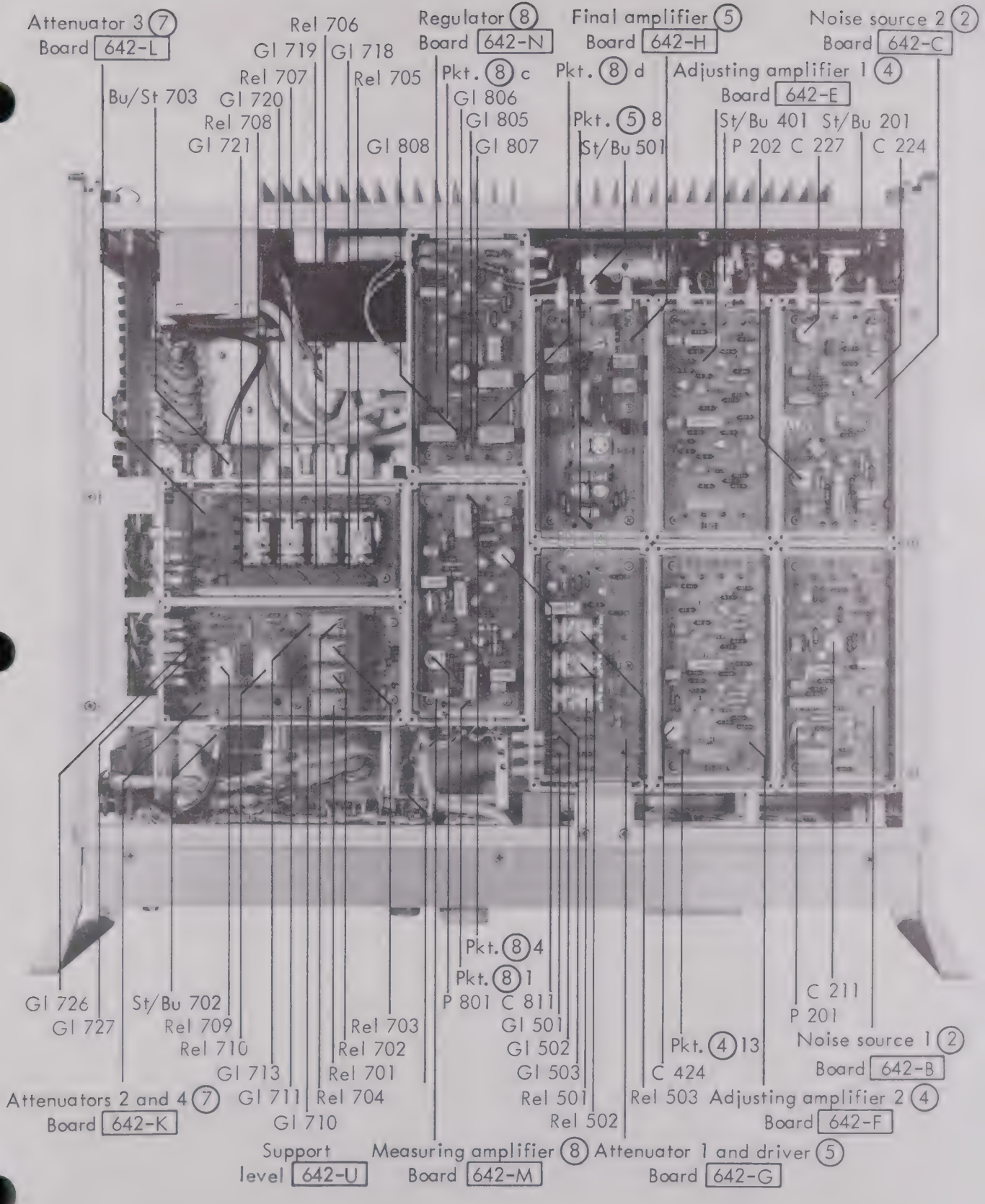


Fig. 7-1 Generator RS-50 : Top view

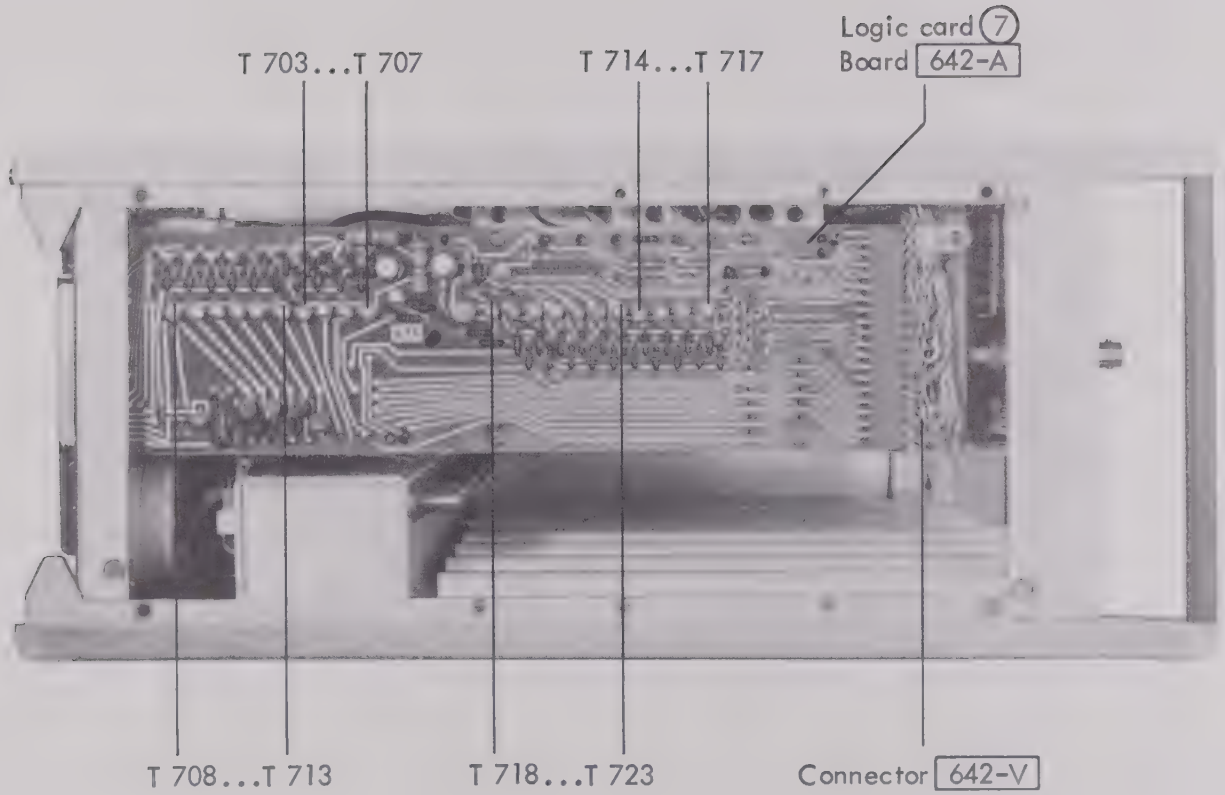


Fig. 7-2 Generator RS-50 : Left view (without protective cover)

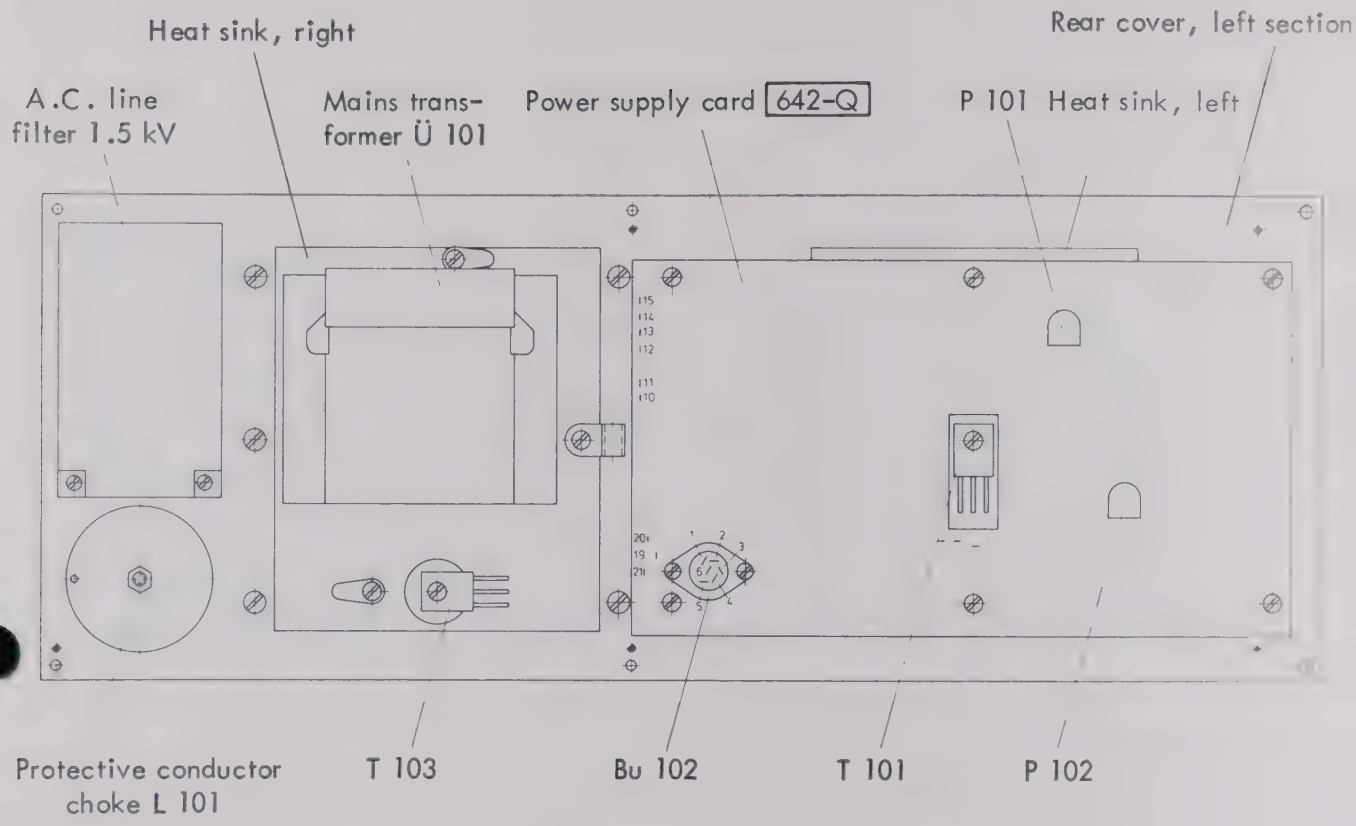


Fig 7-3 Generator RS-50 : View of rear cover, left section

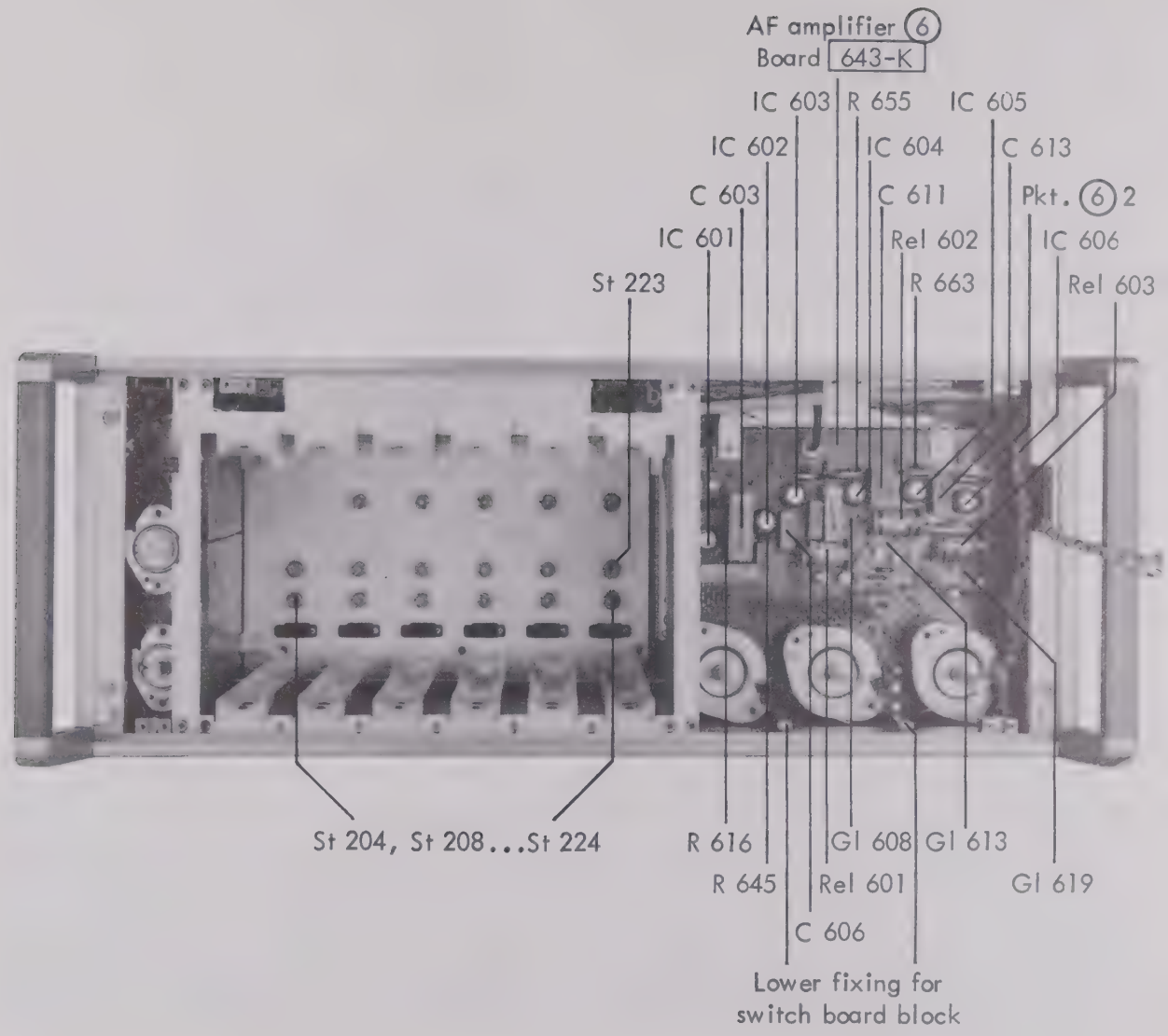


Fig 7-4 Receiver RE-50 : Front view with front panel removed

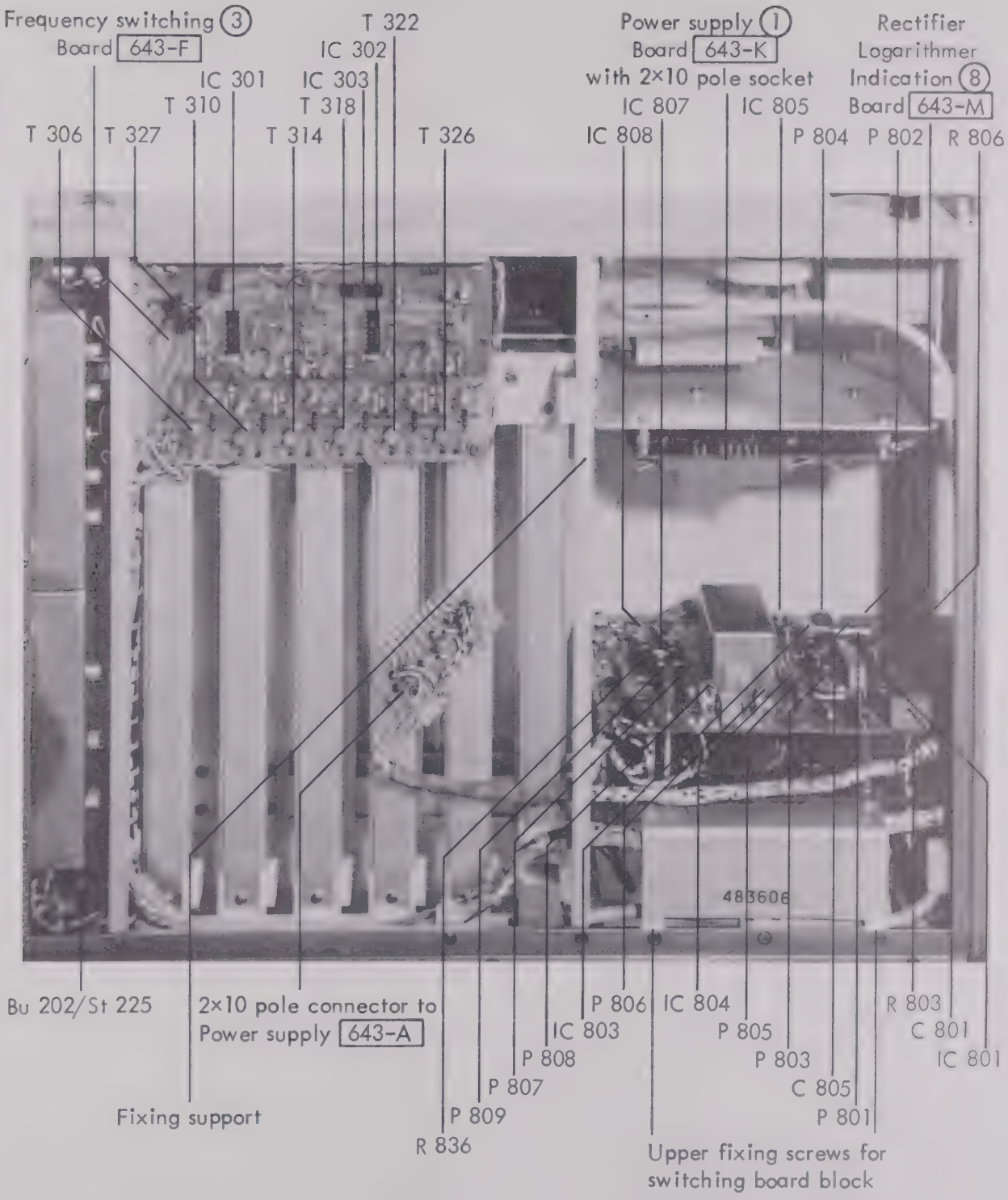


Fig. 7-5 Receiver RE-50 : Top view

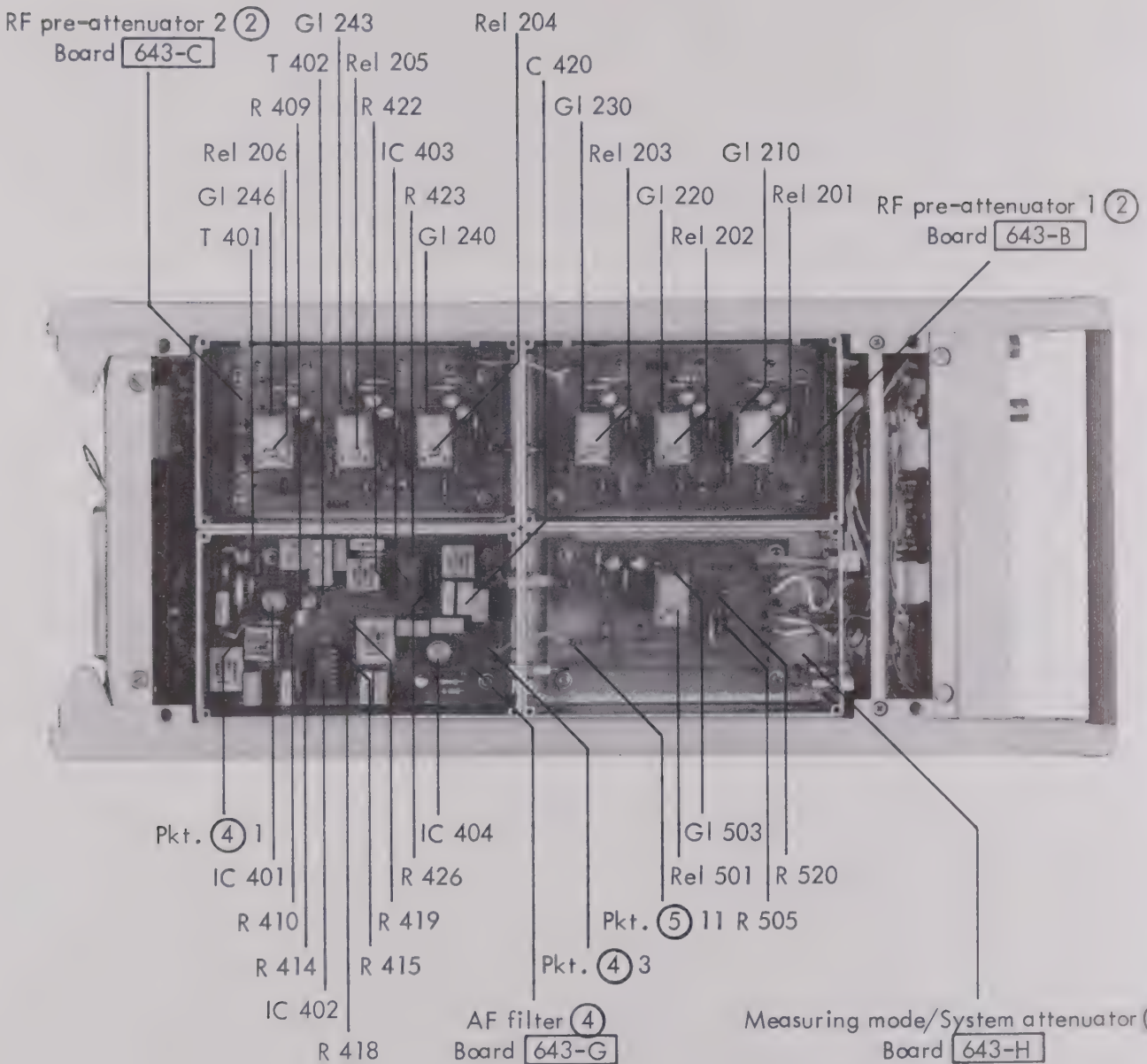


Fig. 7-6 Receiver RE-50 : Left view

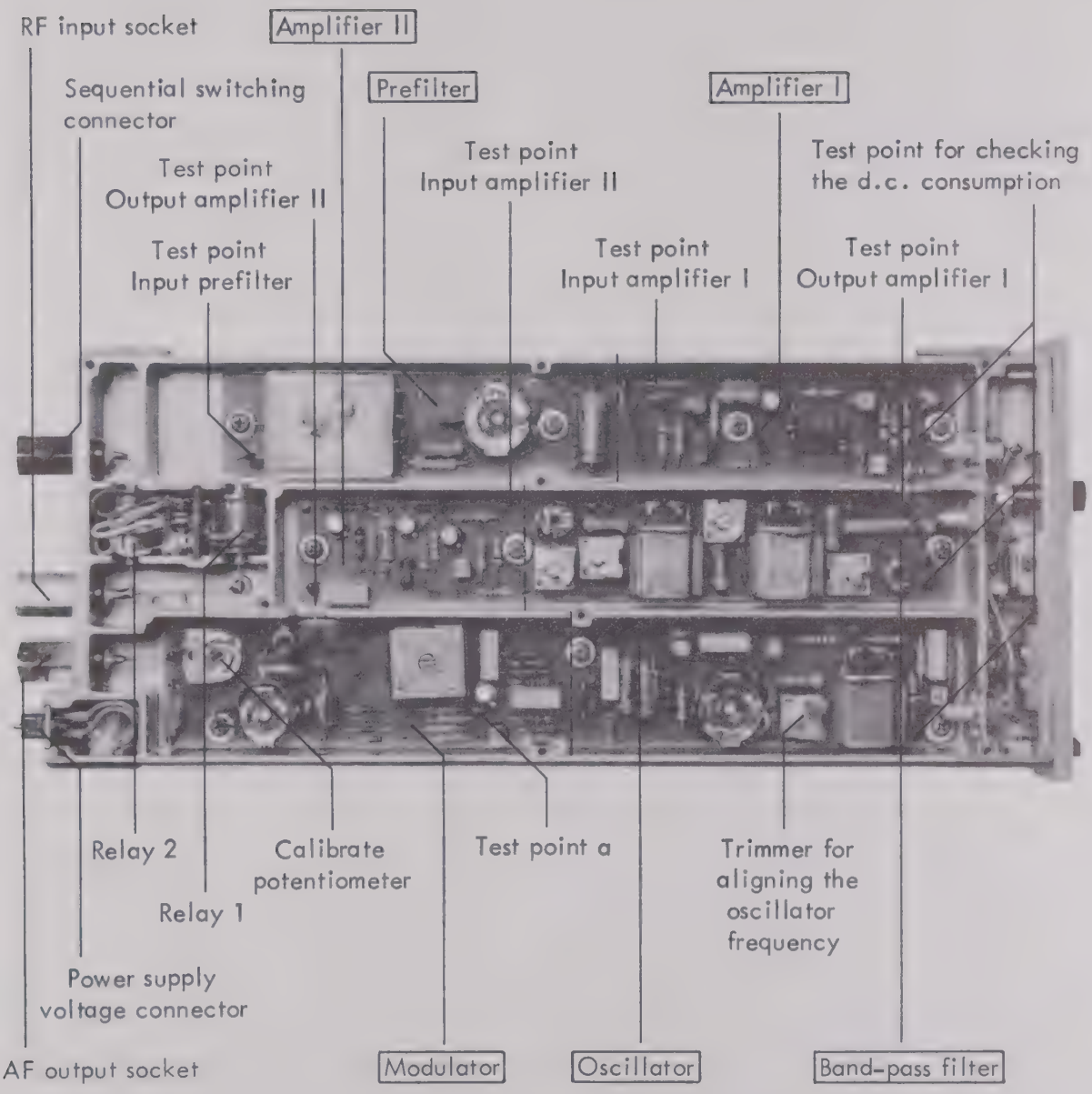


Fig. 7-7 Converter Plug-in REU : Interior of a REU-7600

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

7.6. FAULT FINDING IN THE RS-50 NOISE GENERATOR

7.6.1. Fault Finding Plan

Two types of faults can occur in the RS-50 Noise Generator and are distinguished by the following characteristics:

- Level check lamp SL 701 does not light.
- The level measured at the generator output with a wideband level meter (e.g. W & G REB-50) is not correct although the level check lamp SL 701 is lit.

If a fault of the first type is detected it should first be checked whether there is a handling error, for example 2 RSB buttons depressed simultaneously, a button for an unused plug-in position depressed, filter not correctly fitted.

If this is not the case then fault finding should be carried out with the aid of a fault finding plan.

Working with the Fault Finding Plan:

If the question in a fault finding step is answered with "YES" then follow the line upwards to the next fault finding step. If the question is answered with "NO" then follow the line downwards.

In the case of fault finding steps marked with a number, the appropriate note should be read.

In the case of a fault of the 2nd type, first check whether the fault occurs only in the positions -50 to -21 dBm of the course level switch S 709. If so, attenuator 2 (including the control circuit) should be tested.

A 2nd test checks whether the fault occurs in the positions -50, -40, -30, -20, -10, and 0 dBm. If not, attenuator 4 (including the control circuit) should be checked.

If both of these tests bring no result, fault finding is to be continued with the aid of the level and relay diagrams in Section 7.6.2 and 7.6.6 and the circuit diagrams in the Appendix.

Notes on the Fault Finding Plan:

1.

Set up test configuration as shown in Fig. 7-8:

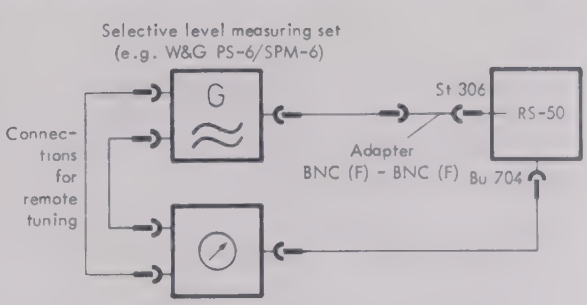


Fig. 7-8

Equipment settings:

PS-6: Output I (coaxial), R_i = Z = 75 Ohm, -42 dBm, frequency setting "SPM-6"

SMP-6: Input coaxial, R_e = Z = 75 Ohm, 1 MHz, bandwidth 0.4 kHz, indication range of meter -22 to +3 dB.

RS-50: Pushbutton "stop filters out" depressed.

Disconnect Subminax connector Bu/St 401 and feed in the sine-wave signal at St 401.

Note:

If an RSSA-50 band stop adapter is available, then this can be used for feeding in the sine-wave signal. In this case it is not necessary to disconnect the Subminax connector St/Bu 401.
The RSSA-50 band stop adapter is to be inserted in RSB position 1 in the generator and the appropriate button is to be depressed. The sine-wave signal can be fed in at the socket marked with ⊸● .

2.

Disconnect Subminax connector St/Bu 501 and connect the selective level meter to plug St 501.

Apart from adjustment of the sensitivity, it is not necessary to change any settings on the level meter.

Note:

If a further RSSA-50 band stop adapter is available, then this can be inserted in RSS position 6 and the appropriate preselection pushbutton depressed, together with the pushbutton "Band Stop Filters In".
The level meter can be connected to the socket marked with ●⊸ without having to disconnect the Subminax connector St/Bu 501.

3.

Change the test configuration shown in Fig. 7-8 so that a sine-wave signal with a level of 0 dBm can be fed into plug St 703 after disconnection of the Subminax connector Bu/St 703.

The generator output Bu 704 is to be terminated with a 75 Ohm plug-in resistor.

Measurement of the level at point 1 on Board 642-M is carried out with the aid of a probe (TK-12 if the SPM-6 is used).

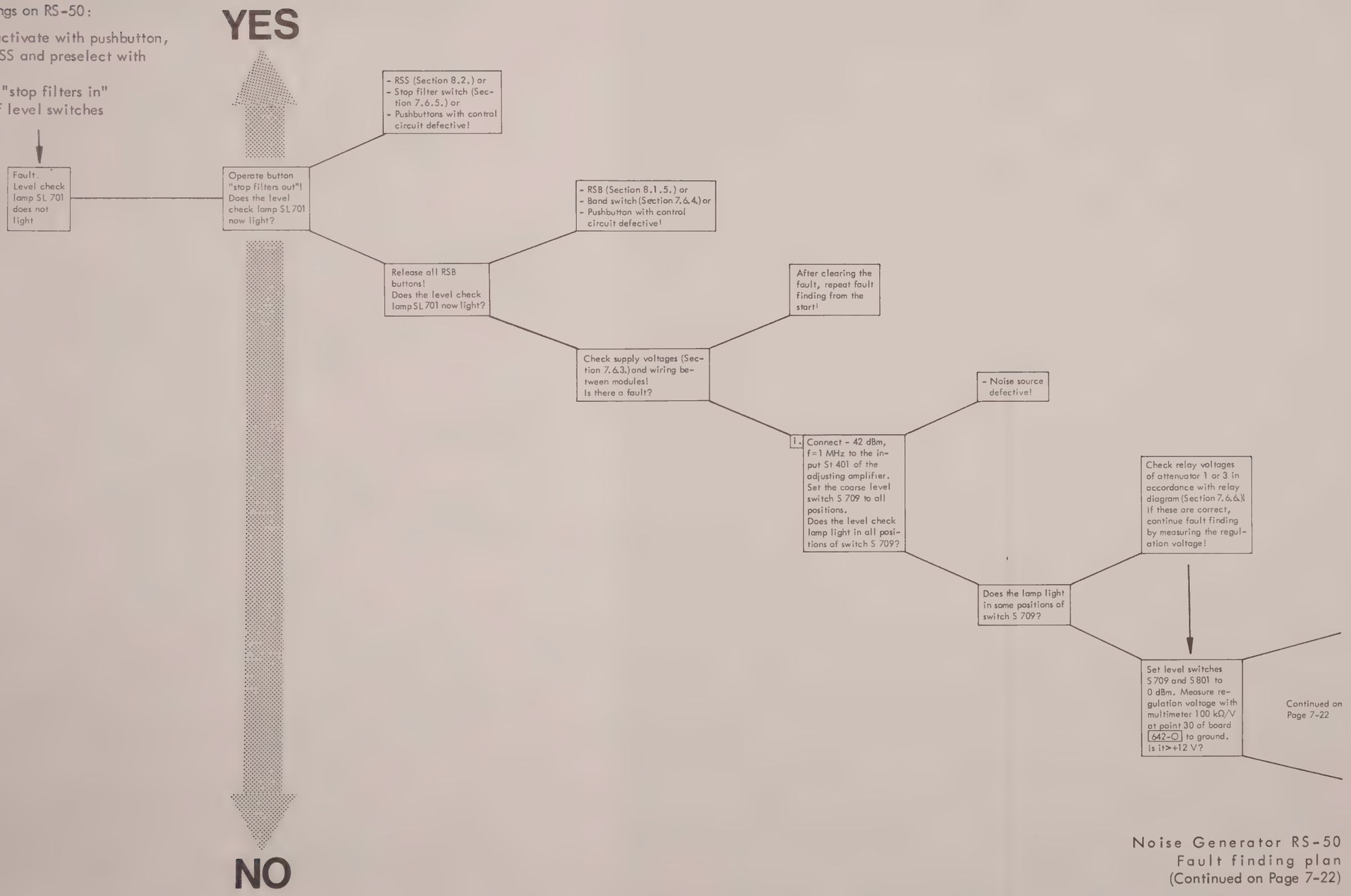
In this case the input resistance of the SPM-6 is to be set to R_e = 10 kOhm

Note:

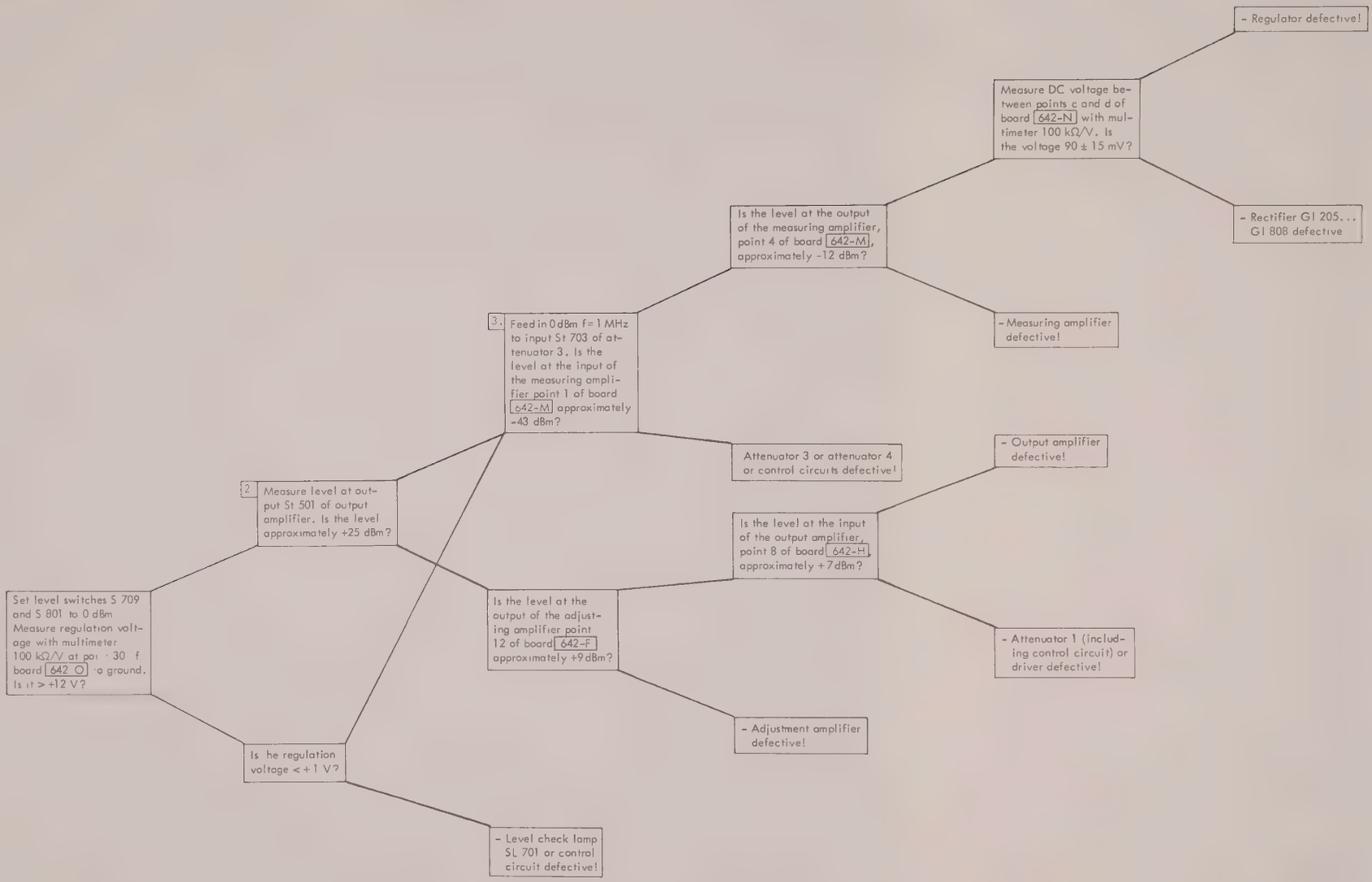
Disconnection of theSubminax connector Bu/St 703 can be avoided by fitting an RSSA-50 in RSS position 1. The RSS preselection button 1 and the button Band Stop Filters In" must also be operated.
The sine-wave signal is fed into the socket of the RSSA-50 marked with ⊸ .

Preliminary settings on RS-50:

- Fit 1 RSB and activate with pushbutton,
- Fit at least 1 RSS and preselect with pushbutton,
- Depress button "stop filters in"
- Any position of level switches


YES
Fault. Level check lamp SL 701 does not light
Operate button "stop filters out"! Does the level check lamp SL 701 now light?
- RSS (Section 8.2.) or
- Stop filter switch (Section 7.6.5.) or
- Pushbuttons with control circuit defective!
- RSB (Section 8.1.5.) or
- Band switch (Section 7.6.4.) or
- Pushbutton with control circuit defective!
Release all RSB buttons! Does the level check lamp SL 701 now light?
After clearing the fault, repeat fault finding from the start!
Check supply voltages (Section 7.6.3.) and wiring between modules! Is there a fault?
- Noise source defective!
1. Connect - 42 dBm, f = 1 MHz to the input St 401 of the adjusting amplifier. Set the coarse level switch S 709 to all positions. Does the level check lamp light in all positions of switch S 709?
Check relay voltages of attenuator 1 or 3 in accordance with relay diagram (Section 7.6.6.)! If these are correct, continue fault finding by measuring the regulation voltage!
Does the lamp light in some positions of switch S 709?
Set level switches S 709 and S 801 to 0 dBm. Measure regulation voltage with multimeter 100 kΩ/V at point 30 of board 642-O to ground. Is it > +12 V?
Continued on Page 7-22
NO

Noise Generator RS-50
Fault finding plan
(Continued on Page 7-22)


- Regulator defective!
Measure DC voltage between points c and d of board 642-N with multimeter 100 kΩ/V. Is the voltage 90 ± 15 mV?
- Rectifier Gl 205... Gl 808 defective
Is the level at the output of the measuring amplifier, point 4 of board 642-M, approximately -12 dBm?
- Measuring amplifier defective!
3. Feed in 0 dBm f = 1 MHz to input St 703 of attenuator 3. Is the level at the input of the measuring amplifier point 1 of board 642-M approximately -43 dBm?
Attenuator 3 or attenuator 4 or control circuits defective!
- Output amplifier defective!
2 Measure level at output St 501 of output amplifier. Is the level approximately +25 dBm?
Is the level at the input of the output amplifier, point 8 of board 642-H approximately +7 dBm?
Set level switches S 709 and S 801 to 0 dBm Measure regulation voltage with multimeter 100 kΩ/V at point 30 f board 642 O to ground. Is it > +12 V?
Is the level at the output of the adjusting amplifier point 12 of board 642-F approximately +9 dBm?
- Attenuator 1 (including control circuit) or driver defective!
- Adjustment amplifier defective!
Is he regulation voltage < + 1 V?
- Level check lamp SL 701 or control circuit defective!

Noise Generator RS-50
Fault finding diagram
(continued from Page 7-21)

7.6.2. Level Diagram

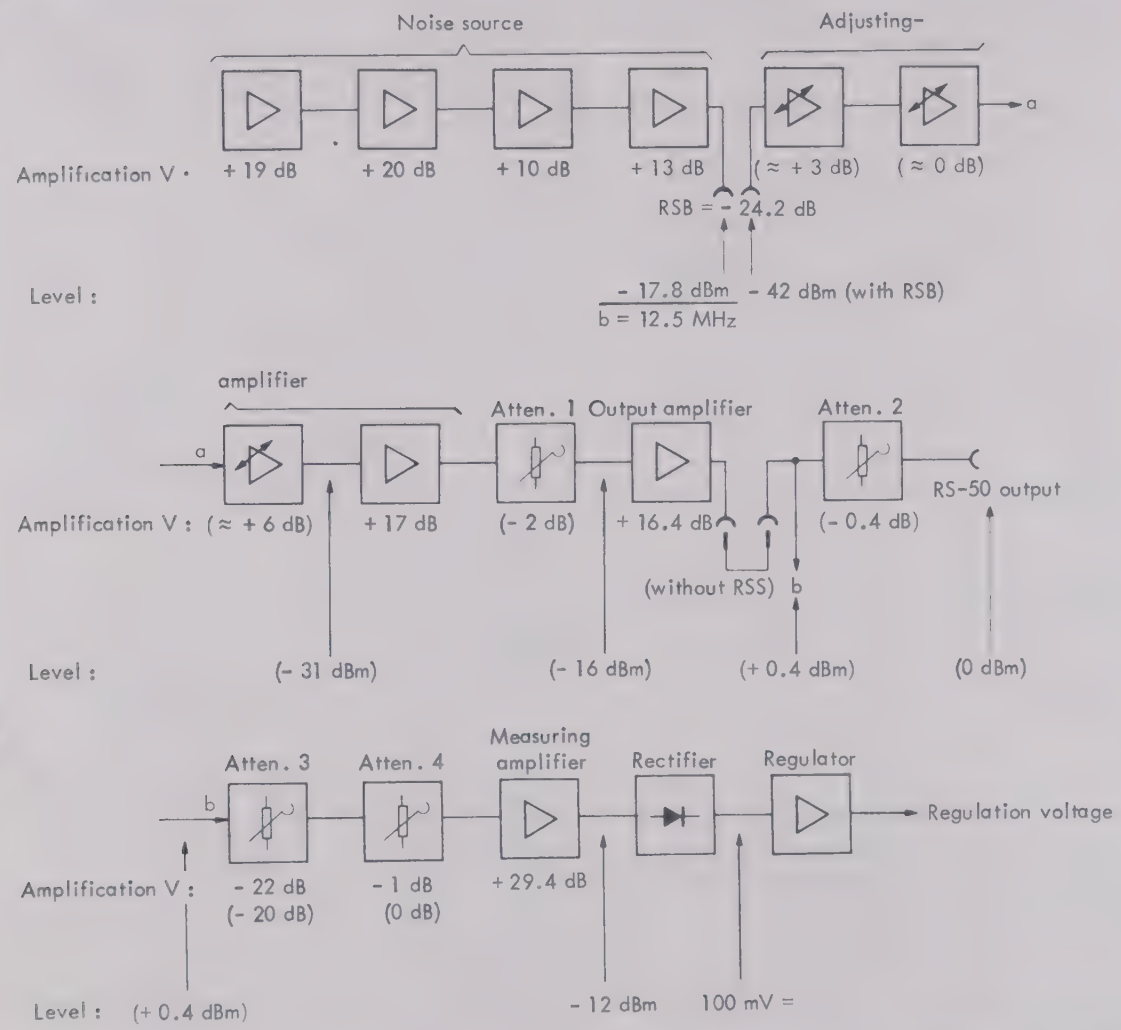


Fig. 7-9 Level diagram for RS-50 noise generator. Specifications in ( ) are referred to the "0 dBm" level setting.

7.6.3. Checking the Supply Voltages

The DC supply voltages can be measured on the 6 pole Hirschmann socket Bu 102. This is located on the power supply card 642-Q which is accessible after removal of the rear cover (see Section 7.3.2).

The plug is to be removed from socket Bu 102 and measurements are to be carried out on the following contacts of the socket as shown in Fig.7-3, using a multimeter 100 kOhm/V:

Bu 102/Pin 3 to Bu 102/Pin 1: +15.2 V +1%

$\bar{B}u$ 102/Pin 4 to Bu 102/Pin 1: -15 V +1%

$\bar{B}u$ 102/Pin 2 to Bu 102/Pin 1: -24 V

7.6.4. Testing the Band Switch

There must be no band limiting filter in the unit when testing the band switch.

Disconnect Subminax connectors St/Bu 201 and Bu/St 401

Connect an Ohmmeter (e.g. AEG multimeter UM-1) between socket Bu 201 (on the RF cable to the band switch) and socket Bu 401 (on the RF cable at the band switch output).

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

Set all pushbuttons for band switching to the position "off". Test the switch according to the conditions shown in Table 8-1 (the RS-50 generator being connected to the mains supply and switched on).

The position of plugs St 301...St 306 is shown in Fig. 7-10.

	"0 Ohm" indication when measuring between Bu 201 and	"0 Ohm" indication when measuring between Bu 401 and
All RSB buttons released	Bu 401	———
Button for RSB position 1 depressed	St 305	St 306
Button for RSB position 2 depressed	St 303	St 304
Button for RSB position 3 depressed	St 301	St 302

Table 7-1

7.6.5. Testing the Band Stop Switch

There must be no band stop filter in the generator when testing the band stop switch.
Disconnect Subminax connectors St/Bu 501 and Bu/St 703.

Connect and Ohmmeter (e.g. AEG UM-1) between sockets Bu 501 and Bu 703.
Set all band stop preselection buttons to the position "off" and depress the button "Band Stop Filters In".
Test the band stop switch according to the conditions shown in Table 7-2 (the generators connected to the mains supply and switched on).

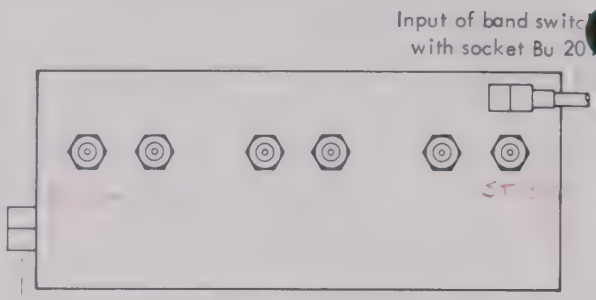


Fig. 7-10 Connections for the band limiting filters (seen from the front panel)

	"0 Ohm" indication when measuring between Bu 501 and	"0 Ohm" indication when measuring between Bu 703 and
No RSS button depressed	Bu 703	
Only RSS button 1 depressed	St 602	St 601
Only RSS button 2 depressed	St 604	St 603
Only RSS button 3 depressed	St 606	St 605
Only RSS button 4 depressed	St 608	St 607
Only RSS button 5 depressed	St 610	St 609
Only RSS button 6 depressed	St 612	St 611

Table 7-2

The position of plugs St 601...St 612 is shown in Fig. 7-11.

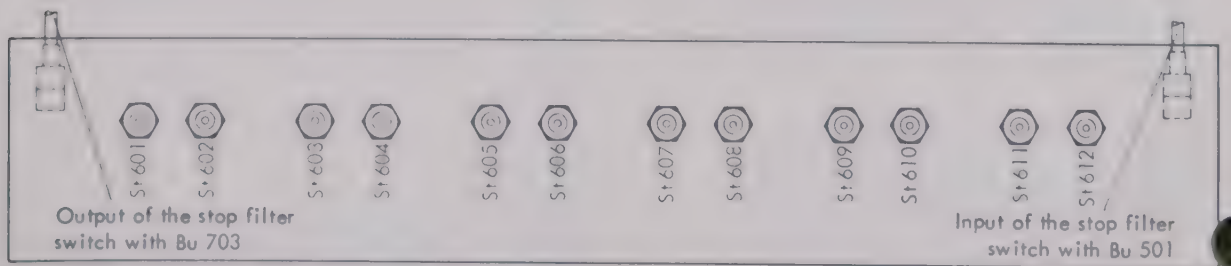


Fig. 7-11 Connections for the band stop filters (seen from the front panel).

Setting of coarse level switch S 709	Attenuator 1			Attenuator 4				Attenuator 3				Attenuator 2	
	Rel 501	Rel 502	Rel 503	Rel 701	Rel 702	Rel 703	Rel 704	Rel 705	Rel 706	Rel 707	Rel 708	Rel 709	Rel 710
- 50			x							(x)	x	x	x
- 49			x				x			(x)	x	x	x
- 48			x			x				(x)	x	x	x
- 47			x			x	x			(x)	x	x	x
- 46			x		x					(x)	x	x	x
- 45			x		x		x			(x)	x	x	x
- 44			x		x	x				(x)	x	x	x
- 43			x		x	x	x			(x)	x	x	x
- 42			x	x						(x)	x	x	x
- 41			x	x			x			(x)	x	x	x
- 40			x							(x)	x		x
- 39			x				x			(x)	x		x
- 38			x			x				(x)	x		x
- 37			x			x	x			(x)	x		x
- 36			x		x					(x)	x		x
- 35			x		x		x			(x)	x		x
- 34			x		x	x				(x)	x		x
- 33			x		x	x	x			(x)	x		x
- 32			x	x						(x)	x		x
- 31			x	x			x			(x)	x		x
- 30			x							(x)	x	x	
- 29			x				x			(x)	x	x	
- 28			x			x				(x)	x	x	
- 27			x			x	x			(x)	x	x	
- 26			x		x					(x)	x	x	
- 25			x		x		x			(x)	x	x	
- 24			x		x	x				(x)	x	x	
- 23			x		x	x	x			(x)	x	x	
- 22			x	x						(x)	x	x	
- 21			x	x			x			(x)	x	x	
- 20			x							(x)	x		
- 19			x				x			(x)	x		
- 18			x			x				(x)	x		
- 17			x			x	x			(x)	x		
- 16			x		x					(x)	x		
- 15			x		x		x			(x)	x		
- 14			x		x	x				(x)	x		
- 13			x		x	x	x			(x)	x		
- 12			x	x						(x)	x		
- 11			x	x			x			(x)	x		
- 10		x							(x)	x			
- 9		x					x		(x)	x			
- 8		x				x			(x)	x			
- 7		x				x	x		(x)	x			
- 6		x			x				(x)	x			
- 5		x			x		x		(x)	x			
- 4		x			x	x			(x)	x			
- 3		x			x	x	x		(x)	x			
- 2		x		x					(x)	x			
- 1		x		x			x		(x)	x			
0	x							(x)	x				
+ 1	x						x	(x)	x				
+ 2	x					x		(x)	x				
+ 3	x					x	x	(x)	x				
+ 4	x				x			(x)	x				
+ 5	x				x		x	(x)	x				
+ 15 V Measured across diode	GI 501	GI 502	GI 503	GI 710	GI 711	GI 712	GI 713	GI 718	GI 719	GI 720	GI 721	GI 726	GI 727

x ≙ relay energized

Table 7-3

7.6.6. Relay Diagram

The +15 V relay voltage can be measured with a multimeter 100 kOhm/V via the diodes specified in Table 7-3.

When the pushbutton for +10 dB level range shift is operated, the relay marked with (x) is energized in various positions of the course level switch S 709.

7.7. FAULT FINDING ON THE BAND LIMITING FILTERS RSB

Fault finding on the band limiting filters RSB is equivalent to a check of the attenuation curve in the stop and pass range. As this is specified for each RSB in Section 1.7 and Table 1-2 of the Operating Instructions, the measurements necessary for checking are described in Chapter 8. CHECKING IMPORTANT TECHNICAL DATA

7.8. FAULT FINDING ON THE BAND STOP FILTERS RSS

The measurement of the attenuation curve of the band stop filters RSS, as described in Chapter 8. CHECKING IMPORTANT TECHNICAL DATA, and comparison with the required values shown in Table 1-3 of the Operating Instructions can be regarded as a fault finding operation

It is sufficient to determine whether a band stop filter is defective as realignment can be carried out only in the factory or in one of our service workshops.

7.9. FAULT FINDING ON THE RE-50 NOISE RECEIVER

7.9.1 Checking the Supply Voltages

Before starting fault finding on the basis of the level and relay diagrams shown in Section 7.9.2 to 7.9.4, the DC supply voltages should be checked at the 2 x 10 pole socket on the power supply board 643-A .

The 2 x 10 pole connector is to be removed from the socket before measuring the DC voltages at the following contacts on the socket using a multimeter 100 kOhm/V:

Pin 5,6,7,8,9 or 10 to Pin 4, D,E,F,H,J:

+12 V ±1%

Pin 1,2,3,A,B, or C to Pin 4,D,E,F,H,J:

-20 V ±1%

7.9.2. Level Diagrams

Fault finding in the noise receiver RE-50 is to be carried out with the aid of the following level diagrams. Using these level diagrams, the AF signal path after conversion by the REU can be checked.

The specifications in Sections 7.9.3 and 7.9.4 are used for checking the RF path as far as the converter plug-ins REU.

The following test configuration is to be set up for working with the level diagrams:

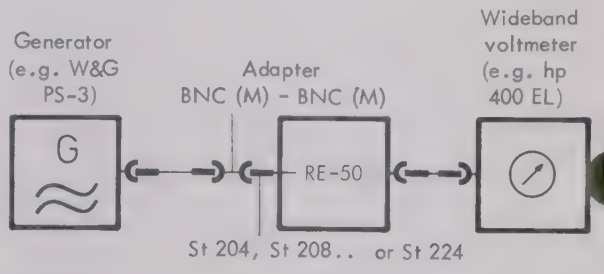


Fig. 7-12

Unit settings:

PS-3: -44.3 ±0.3 dB
$R_i \approx 0$ Ohm, unbalanced
f = 600 Hz

RE-50: Fine reference level switch S 601: 0 dBr
Course reference level switch S 602: -40 dBr
Measuring range switch S 603: - 10 dBmOp/dB
Measuring mode/system switch S 501: ≥ 240.

The values specified in the level diagrams are to be measured with a meter having a high input impedance.

7.9.2.1. AF Signal Path

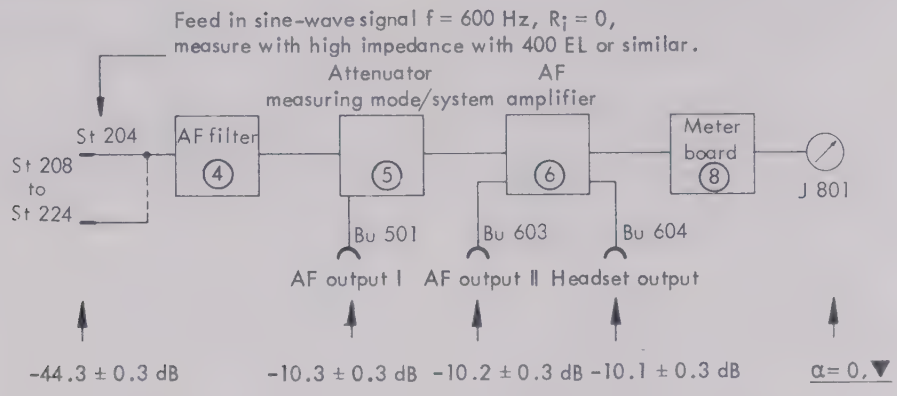


Fig. 7-13

7.9.2.2. AF Filters

- for series A and B units:

Fig. 7-14

- for units from series C onwards:

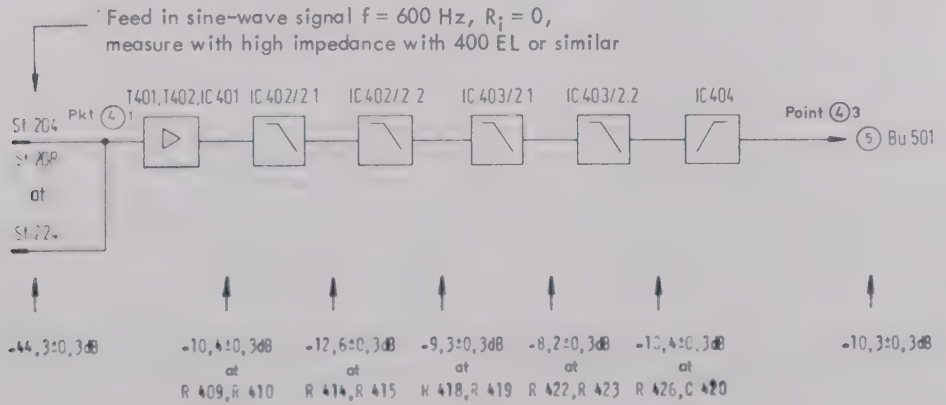


Fig. 7-15

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

7.9.2.3. Measuring Mode/System Attenuator and AF Amplifier

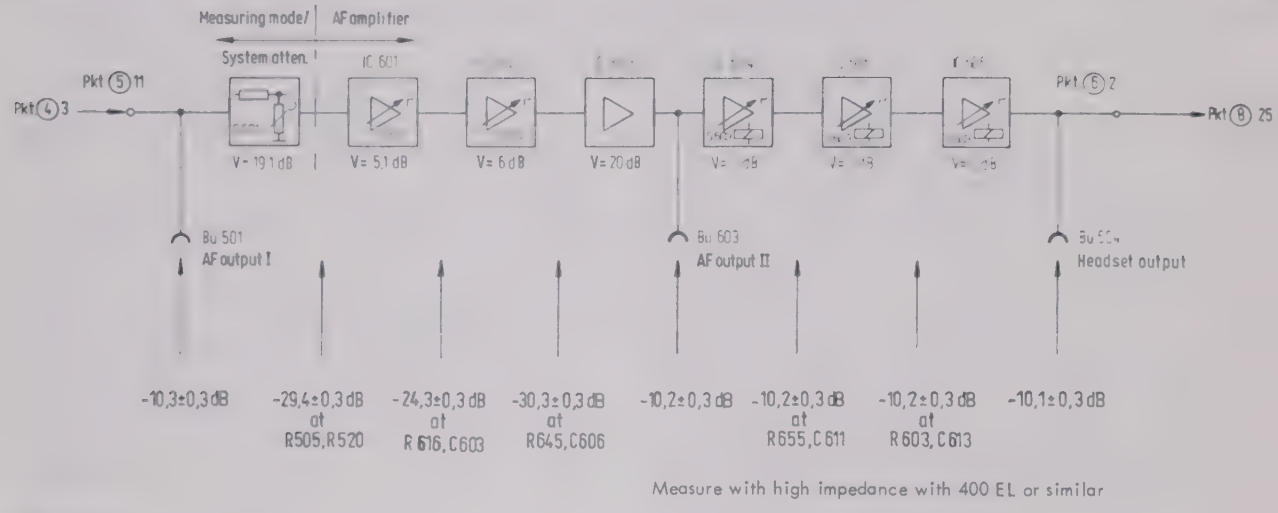


Fig. 7-16

7.9.2.4. From Rectifier to Meter

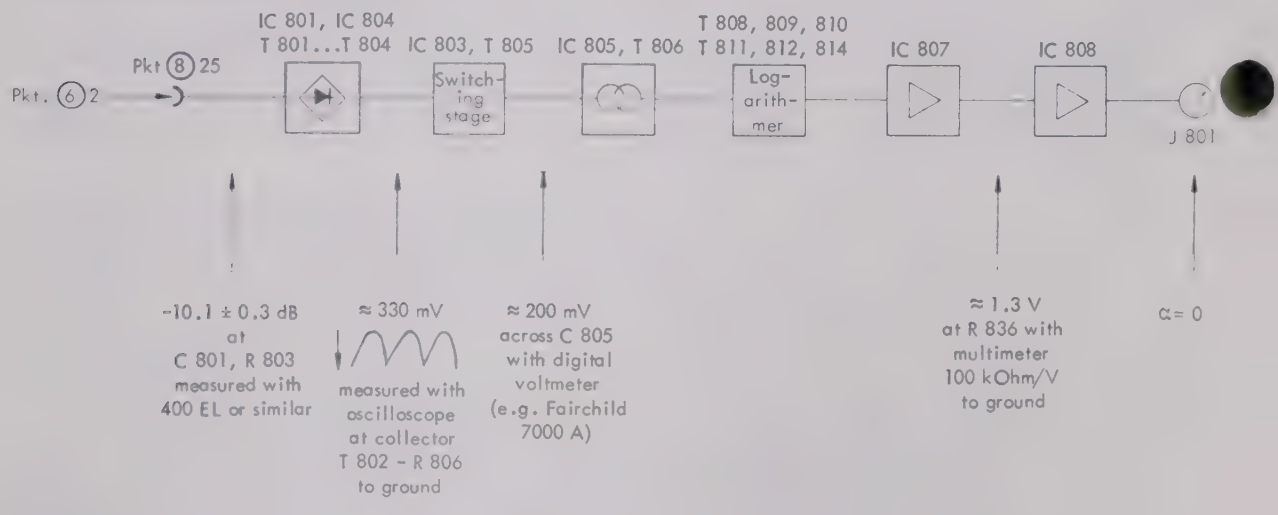

IC 801, IC 804
T 801...T 804
IC 803, T 805
IC 805, T 806
T 808, 809, 810
T 811, 812, 814
IC 807
IC 808
Pkt. (6) 2
Pkt (8) 25
Switching stage
Logarithmer
J 801
-10.1 ± 0.3 dB at C 801, R 803 measured with 400 EL or similar
≈ 330 mV
measured with oscilloscope at collector T 802 - R 806 to ground
≈ 200 mV across C 805 with digital voltmeter (e.g. Fairchild 7000 A)
≈ 1.3 V at R 836 with multimeter 100 kOhm/V to ground
α = 0

Fig. 7-17

7.9.3. Checking the RF Signal Path

The test configuration shown in Fig. 7-18 is to be set up for checking the RF signal path from the receiver input Bu 201 to the REU input St 223.

Unit settings:

PS-6: Output 1 (coaxial), R_i=Z=75 Ohm, 0 dBm, frequency setting "SPM-6"

SPM-6: Input coaxial, R_e=Z=75Ohm, 1 MHz, bandwidth 0.4 kHz, meter indication range -22 to +3 dB.

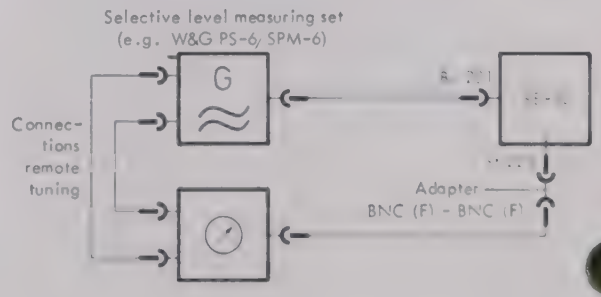


Fig. 7-18

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

Position of switch S 602	Position of switch S 603	Attenuation connected 2 dB	4 dB	8 dB	16 dB	10 dB	20 dB	Total atten. dB
- 8	▲	x	x	x	x			30 + 0
- 10			x	x	x			28 + 0
- 12		x		x	x			26 + 0
- 14				x	x			24 + 0
- 16		x	x		x			22 + 0
- 18			x		x			20 + 0
- 20		x			x			18 + 0
- 22	≤ - 20				x			16 + 0
- 24		x	x	x				14 + 0
- 26			x	x				12 + 0
- 28		x		x				10 + 0
- 30				x				8 + 0
- 32		x	x					6 + 0
- 34			x					4 + 0
- 36		x						2 + 0
- 38	▼							0 + 0
- 38	- 10					x		0 + 10
- 38	▼						x	0 + 20

Table 7-4

Preattenuators 1 and 2 are to be tested in accordance with Table 7-4. A level meter indication reduced by the overall attenuation is to be expected if the unit is operating correctly.

7.9.4. Relay Diagram

If a fault is detected by the procedure in Section 7.9.3, it is possible to localize it further to a possibly defective relay with the aid of the relay diagram shown in Table 7-5.

The relay voltage of approximately +12 V can be measured witha multi-meter 100 kOhm/V via the doides specified in the Table.

7.10. FAULT FINDING ON THE CONVERTER PLUG-INS REU

7.10.1. Checking the Amplification of a Converter Plug-in

A simple check of a converter plug-in is possible by means of an amplification

Switch	Position	Rel 201	Rel 202	Rel 203	Rel 204	Rel 205	Rel 206	Rel 501	Rel 601	Rel 602	Rel 603
S 602 ▲	- 8										
	- 10	x									
	- 12		x								
	- 14	x	x								
	- 16			x							
	- 18	x		x							
	- 20		x	x							
	- 22	x	x	x							
	- 24				x						
	- 26	x			x						
	- 28		x		x						
	- 30	x	x		x						
	- 32			x	x						
	- 34	x		x	x						
	- 36		x	x	x						
▼	- 38	x	x	x	x						
S 603 ▲	▼						x	x			
	- 10					x					
	- 20										
	- 30								x		
	- 40									x	
	- 50								x		x
	- 60									x	x
▼	- 70								x	x	x
+ 12 V measured across diode		Gl 210	Gl 220	Gl 230	Gl 240	Gl 243	Gl 246	Gl 503	Gl 608	Gl 613	Gl 619

x ≙ relay energized

Table 7-5

Effective limit frequency of noise band in kHz	Effective noise bandwidth f_s in kHz	Indication in dBm0p for p_r = - 10 dBr
6 to 54	48	- 14.4
6 to 60	54	- 14.9
6 to 108	102	- 17.7
12 to 60	48	- 14.4
12 to 108	96	- 17.4
12 to 156	144	- 19.2
12 to 252	240	- 21.4
12 to 300	288	- 22.2
12 to 408	396	- 23.6
12 to 552	540	- 24.9
12 to 804	792	26.6
12 to 1052	1040	- 27.8
12 to 1296	1284	- 28 7
12 to 1796	1784	- 30.1
12 to 2600	2588	- 31.7
12 to 3284	3272	- 32.7
12 to 4100	4088	- 33.7
12 to 4892	4880	- 34.5
12 to 8160	8148	- 36.7
60 to 108	48	- 14.4
60 to 300	240	- 21.4
60 to 552	492	- 24.5
60 to 1052	992	- 27.6
60 to 1296	1236	- 28.5
60 to 2600	2540	- 31.6
60 to 4100	4040	- 33 7
60 to 5600	5540	- 35.0
316 to 552	236	- 21.3
316 to 4100	3784	- 33.4
316 to 5600	5284	- 34.8
316 to 8160	7844	- 36.5
316 to 12360	12044	- 38.4

Table 7-6 Required values of level indication with bridged band stop filters, sum level - 10 dBm at receiver input, and setting to a relative level of - 10 dBr.

measurement. The REU to be tested is plugged into the rightmost position in a functional noise receiver RE-50 - with a 2nd REU to the left of it for heating reasons - and run for approximately half an hour (i.e. it must be preselected and switched on).

If no noise level standard is available, a noise generator RS-50 with a noise band of bandwidth Δf_s, which contains the REU frequency to be checked, can be used for generation of the signal. A sum level of -10 dBm, set up on the RS-50 generator with the band stop filter bridged, is connected to the receiver input. This level must be checked for accuracy with a calibrated level meter.

In the calibrated receiver, a value reduced by the bandwidth ratio

$$10 \lg \frac{\Delta f_s}{1.74 \text{ kHz}}$$

should then be indicated.

Table 7-6 shows the expected indication on the receiver for a sum level of -10 dBm for all noise bandwidths which can be implemented with the RS-50 generator and the available band limiting filters RSB is the following settings are used on the receiver:

Measuring mode/system switch S 506:
Position S/N
Reference level switch S 602:
Position -10 dBr
Reference level switch S 601:
Position 0 dBr.

The measuring range switch S 603 is to be adjusted so that a favourable indication results on the meter. Addition of the meter indication (upper scale) and the setting of the measuring range switch results in the values shown in Table 7-6 if the unit operates correctly.

Alignment is possible with the calibration potentiometer (Fig. 7-7) in the case of slight deviations ($< \pm 1$ dB) from the required values shown in the Table. The calibration potentiometer is accessible through the cover plate of the REU if the 2nd converter is removed from the receiver.

In the case of larger deviations, fault finding should be carried out in accordance with the fault finding diagram of Section 7.10.3.

7.10.2. Checking the Relay Circuit

The relay circuit of the object being tested (1st converter) can be checked with the test configuration shown in Section 7.10.1. If the 2nd converter is connected in with the REU preselection switch S 301 on the RE-50 receiver then the indication shown in Table 7-6 must again appear on the receiver providing this REU frequency is also within the transmitted noise band.

This means, for the relay circuit of the 1st converter plug-in, that REL 2 is closed and REL 1 is open, as shown in Fig. 10-23.

If there is no meter indication on the RE-50 receiver then it cannot always be assumed that the relay circuit of the converter being tested is defective. A final decision can be made only after exchanging the positions of the 2 converters and repetition of the measurement.

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

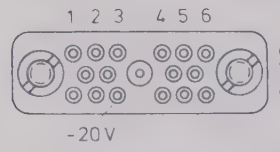


Fig. 7-19 Pin assignments of plug for DC supply of the REU

7.10.3. Fault Finding Diagram

On the basis of the measurements in Section s 7.10.1 and 7.10.2, it is possible to determine whether the fault is to be found in the circuit of the plug-in or whether the relay circuit is defective.

The main faults in the converter plug-in can be determined with the aid of the fault finding diagram.

The converter plug-in is operated outside the basic unit for fault finding purposes. The DC voltage supply is provided by means of a 16 pole plug (Tuchel Type T 2664) with -20 V on Pin c3 and the positive pole connected to ground.

The plug is to be inserted in the supply voltage socket of the REU.

If no plug of the specified type is available, the voltage can be fed to the converter by soldering a wire to the center contact of the pilot lamp.

From fault finding step [2.] of the fault finding plan onwards, the test configuration shown in Fig. 7-10 is to be used. Two special plugs are required for connection of the REU. It is however possible to fabricate such a plug by using 2 cables with BNC plugs and cutting off the bayonet pins of 1 plug in each case.

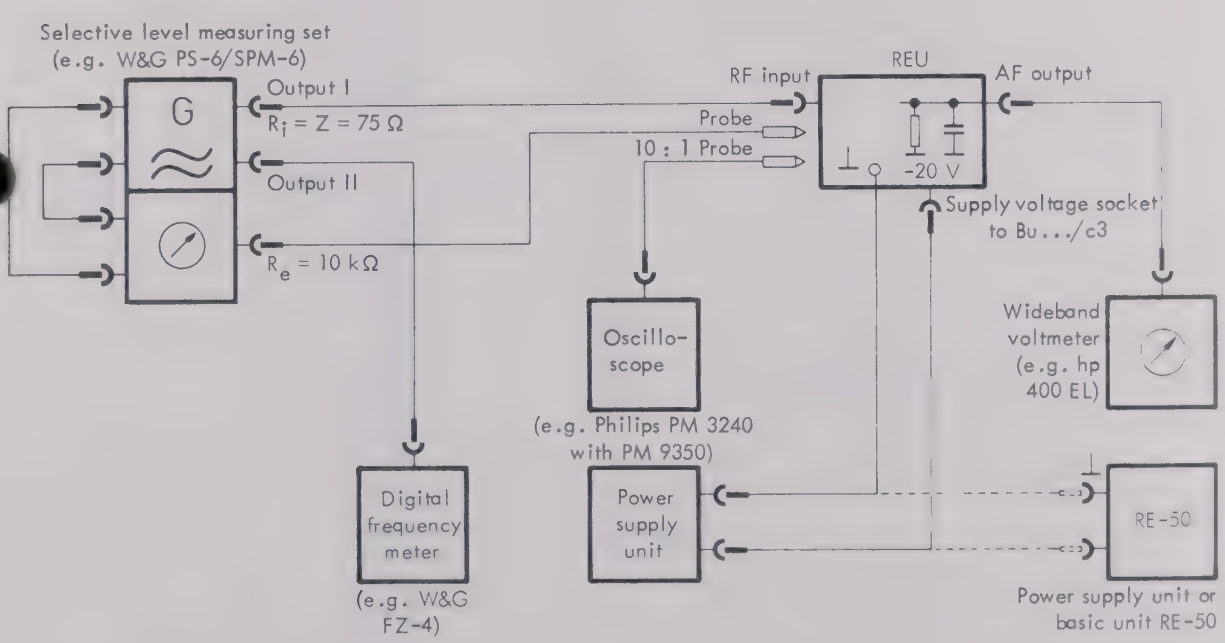
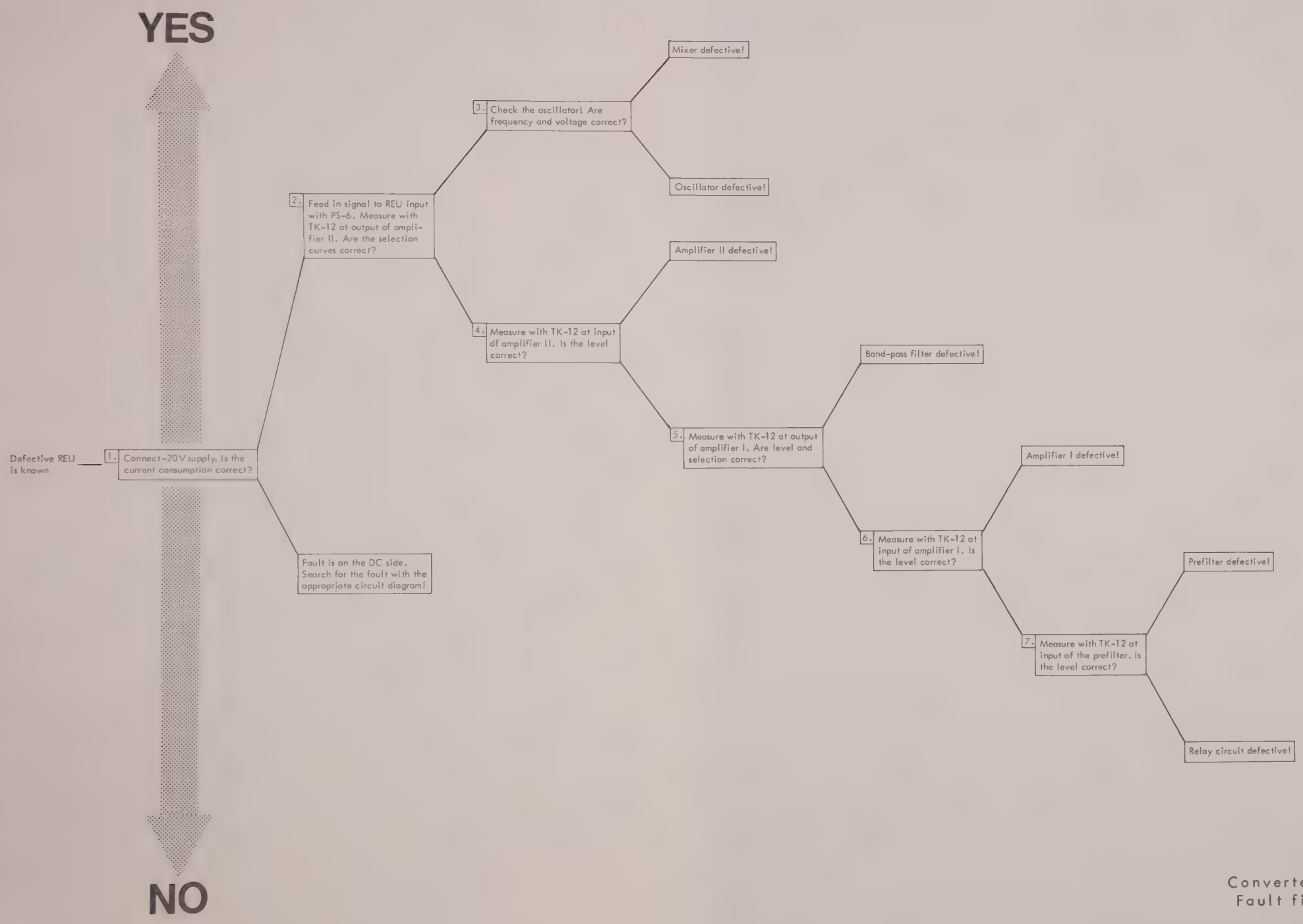


Fig. 7-20


YES
Defective REU is known
1. Connect -20 V supply. Is the current consumption correct?
Fault is on the DC side. Search for the fault with the appropriate circuit diagram!
2. Feed in signal to REU input with PS-6. Measure with TK-12 at output of amplifier II. Are the selection curves correct?
3. Check the oscillator! Are frequency and voltage correct?
Mixer defective!
Oscillator defective!
4. Measure with TK-12 at input of amplifier II. Is the level correct?
Amplifier II defective!
5. Measure with TK-12 at output of amplifier I. Are level and selection correct?
Band-pass filter defective!
6. Measure with TK-12 at input of amplifier I. Is the level correct?
Amplifier I defective!
7. Measure with TK-12 at input of the prefilter. Is the level correct?
Prefilter defective!
Relay circuit defective!
NO

Converter plug-in REU
Fault finding diagram

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

Notes for Fault Finding Diagram

1. DC current consumption

Open the cover of the REU:
The current consumption of the 3 boards is measured by measuring the voltage drop across the filter resistors on the boards with a DC multimeter. The required values are shown in the circuit diagrams of the REU.

2. Checking up to amplifier II (output)

Test configuration as shown in Fig. 7-20.

A voltage level of -40 dB (R_i=75 Ohm) at the rated frequency ±100 Hz is connected to the input of the REU (center socket). The output of amplifier II is then measured at the strap between Board 2 and 3 using a probe.

During this test, the wiper of the calibration potentiometer is carefully lifted and insulated with a small piece of paper. A level of approximately -11.5 dB should then be measured (this level may vary by ±2 dB depending on the type of REU).

If the signal is present up to the output of amplifier II, the selection curve should be checked. The following exmples in Figs. 7-21 to 7-31 show the typical shape of some REU selection curves.

If the filters are obviously misaligned and if there is therefore a loss of amplification, the realignment should be carried out in the factory.

At higher frequencies the cover may effect the selection and the oscillator frequency. For this reason, this effect should be checked from case to case by replacing the cover and the effect should be taken into account.

3. Checking the Oscillator

Remove the cover of the REU.
Solder in a 100 kOhm resistor in parallel with a 3.3 NF capacitor as a termination resistor in front of the AF output and replace the cover again.

Set up the test configuration as shown in Fig. 7-20.

A voltage level of -46 dB (R_i=75 Ohm) at the rated frequency of the REU (exception for REU-10: 9.24 kHz) is applied to the RF input of the converter plug-in. The AF output is measured with a wideband voltmeter (limit frequency =10 Hz).

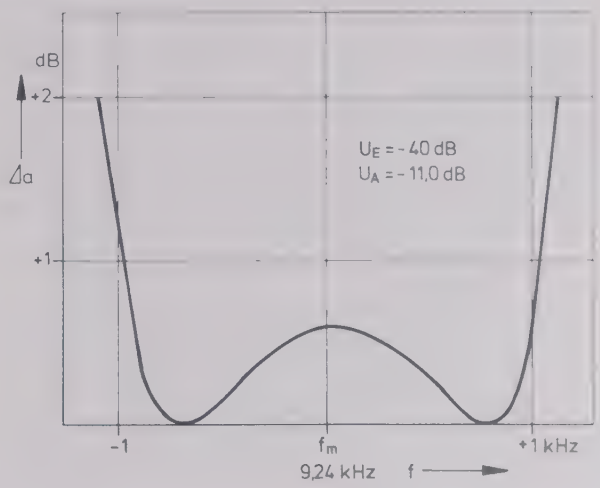


Fig. 7-21 Selection curve REU-10
REU input-amplifier II output

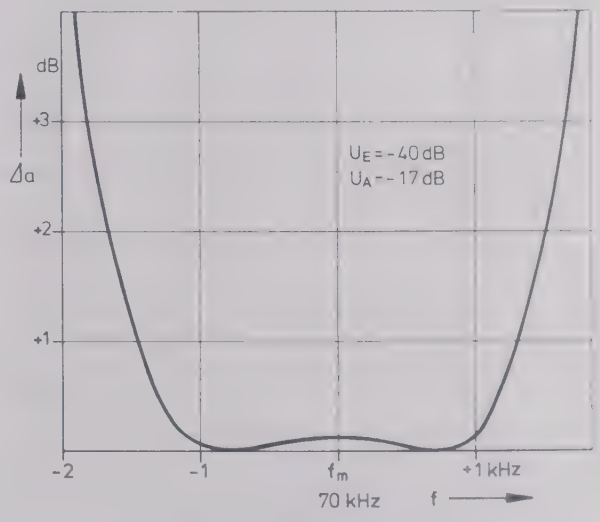


Fig. 7-22 Selection curve REU-70
REU input-amplifier II output

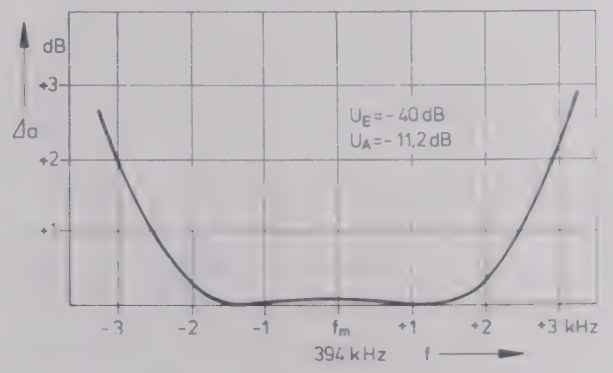


Fig. 7-23 Selection curve REU-394
REU input-amplifier II output

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

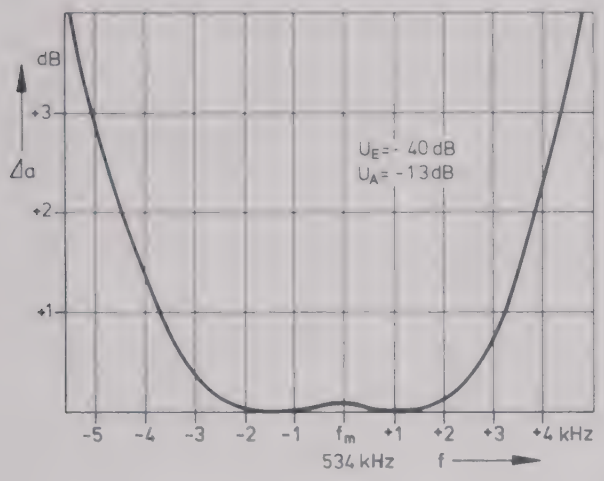


Fig. 7-24 Selection curve REU-534
REU input-amplifier II output

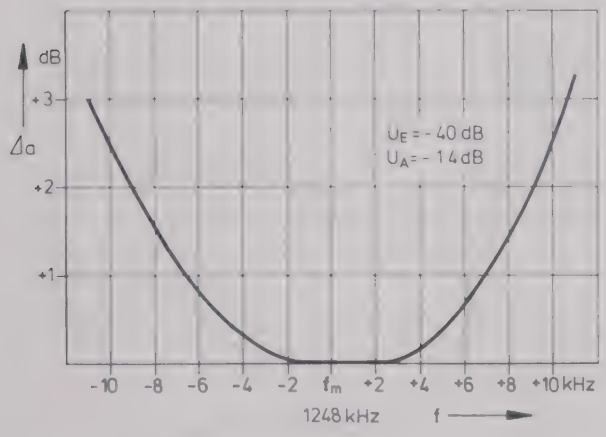


Fig. 7-25 Selection curve REU-1248
REU input-amplifier II output

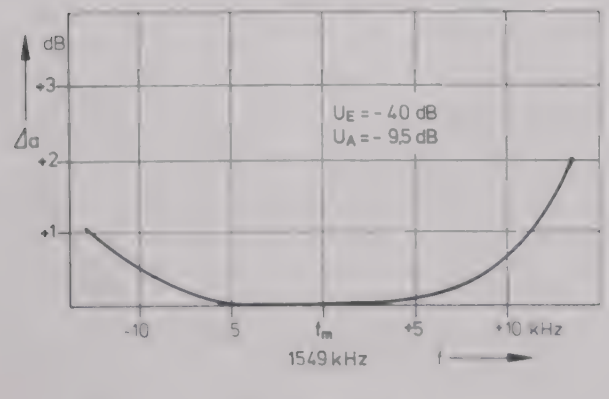


Fig. 7-26 Selection curve REU-1549
REU input-amplifier II output

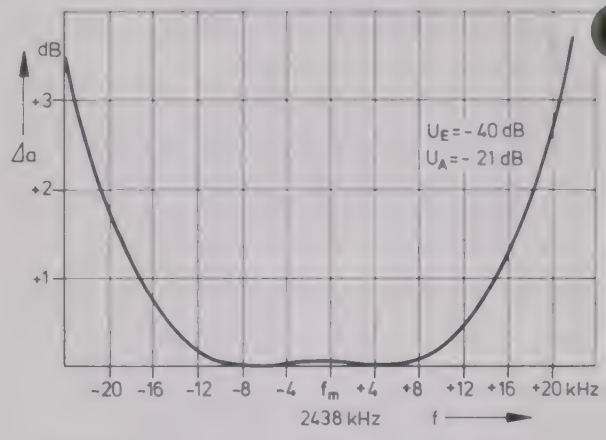


Fig. 7-27 Selection curve REU-2438
REU input-amplifier II output

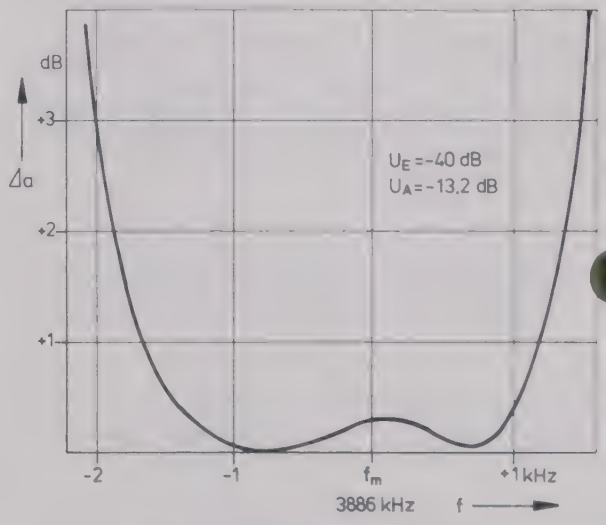


Fig. 7-28 Selection curve REU-3886
REU input-amplifier II output

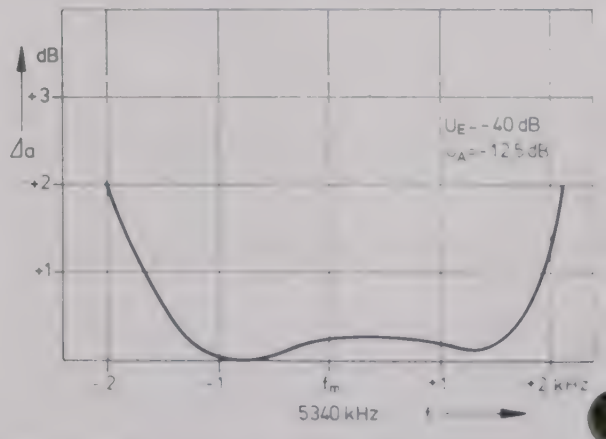


Fig. 7-29 Selection curve REU-5340
REU input-amplifier II output

7. FAULT LOCALIZATION AND REPAIR INSTRUCTIONS

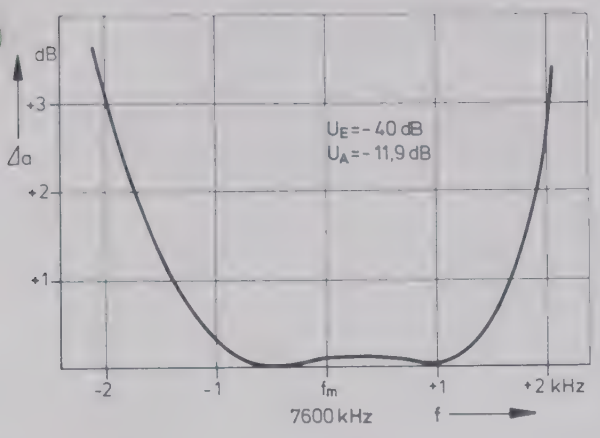


Fig. 7-30 Selection curve REU-7600
REU input-amplifier II output

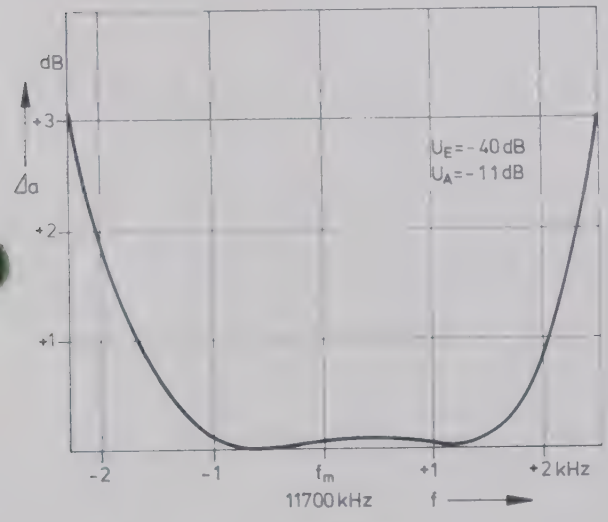


Fig. 7-31 Selection curve REU-11700
REU input-amplifier II output

The frequency is now adjusted slowly until the voltmeter indicates a maximum (level approximately -20 dB). The frequency should then be exactly the rated frequency ±50 Hz (connect a digital frequency meter to output II of the signal generator).

If the oscillator is incorrectly aligned, it can be tuned with the trimmer through the hole in the cover (Fig. 7-7). The oscillator voltage can be checked with an oscilloscope and probe at test point a (Fig.7-7).

Required value: Approximately 2 V_{pp}, approximately square-wave.

See Fig. 7-32.

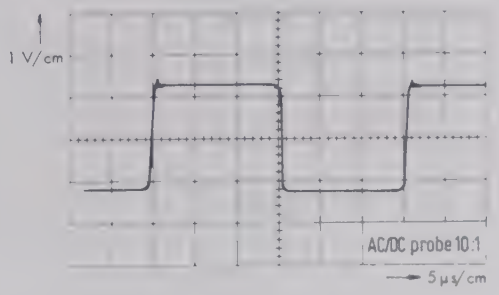


Fig. 7-32 Voltage at test point a (here on REU-331)
PM 3240 with PM 9350:
Vertical sensitivity: 0.1 V/cm
Sweep speed: 0.5 µs/cm
AC/DC probe 10 : 1

[4.] Checking as far as amplifier II (input).

This is the continuation of the measurement in fault finding step [2.], if the signal does not reach the output of amplifier II.

The level is applied as specified in [2.] (-40 dB, R_i=75 Ohm). The level at the input of amplifier II is then checked with the probe via approximately 0.1 µF:

Required value approximately -22 dB.

The selection curve of the filter cannot be checked here as the probe effects the curve shape.

[5.] Checking as far as amplifier I (output).

The level is applied as in step [2.] The connection to the band-pass filter board is disconnected. The output level of amplifier I is then checked with the probe via approximately 0.1 µF:

Required value approximately -30 dB.

If the RF signal is present, the selection curve can be checked. The maximum voltage value should then be attained at the rated frequency and the selection curve should ve symmetrical.

A few 1 dB bandwidths:

9.24	kHz ±	0.7 kHz
70	kHz ±	1 kHz
394	kHz ±	5 kHz
534	kHz ±	6.5 kHz
1284	kHz ±	14 kHz
1549	kHz ±	20 kHz
2348	kHz ±	30 kHz
3886	kHz ±	50 kHz
5340	kHz ±	60 kHz
7600	kHz ±	80 kHz
11700	kHz ±	120 kHz

[6.] Checking as far as amplifier I (input).

The level is applied as in step [2] Then check the level at the input of amplifier I at the disconnection point a-b using the probe:

Required value approximately -30 dB.

[7.] Checking as far as prefilter Input).

If no signal can be measured in the step above, the input of the prefilter is measured with the probe:

Required value -40 dB.

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

The following sections describe methods which permit checking of the most important characteristics of the units. As far as possible, commercially available measuring equipment is suggested.

If not otherwise specified, the tests should be carried out at room temperature (+23°C ±3°C) and after a warming up period of 20 minutes.

Checking of the most important data is intended to determine whether the indication of a measured parameter is within the guaranteed error limits. This check can be regarded as successful without restrictions only if the intrinsic error of the test configuration used is negligible.

Otherwise, the following rule is valid:

If ±e is specified as the guaranteed error limits for the test object and if the error of the test configuration used is ±m, then

a value outside the limits ± (e + m) indicates that the guaranteed error limits are certainly exceeded;

a value within the limits ± (e - m) indicates that the guaranteed error limits are certainly maintained.

The value e is specified for each step. The value m depends on the test equipment used and must therefore be determined from case to case. The measuring instructions give a value for m only when the prescribed test equipment permits no variation or if special conditions are to be observed.

For a systematic check of the data, the tests should be carried out in the sequence specified here.

Alignment of the test object should be carried out only when the tests indicate that the limit ± (e + m) is exceeded The necessary alignment operations are described in Chapter 9.

8.1. NOISE GENERATOR RS-50

The checks described in Sections 8.1.1 to 8.2.3 detect the most important partial errors of the error limits of the output level specified in the Technical Data.

8.1.1. Error Limits of the Output Level at 0 dBm

Measuring configuration:

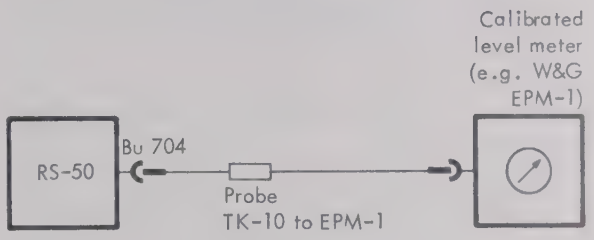


Fig. 8-1

Equipment settings:

RS-50: Level 0 dBm, any band limiting filter inserted, band stop filters "off".
EPM-1: Indication range ±0.2 dBm, calibrated at 0 dBm, R_i=75 Ohm.

Read off the output level on the EPM-1:

Error limits (e) of the output level: ±0.4 dB.

8.1.2. Error Limits of the Fine Level Control

Use the test configuration shown in Fig. 8-1.
Set the indication range of the EPM-1 to ±1 dB.

Switch the fine level control S 801 in 0.1 dB steps and observe the indication on the EPM-1.

Error limits (e) for the fine level control: ±10% of the selected value.

8.1.3. Error Limits of the Output Level Attenuator

Measuring configuration:

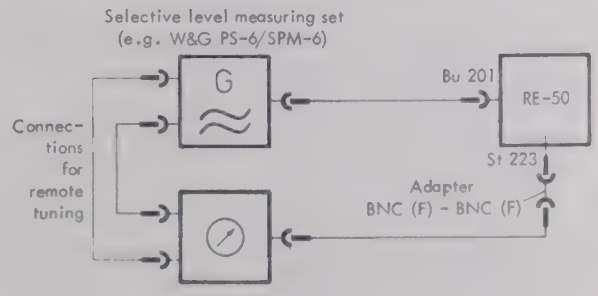


Fig 8-2

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

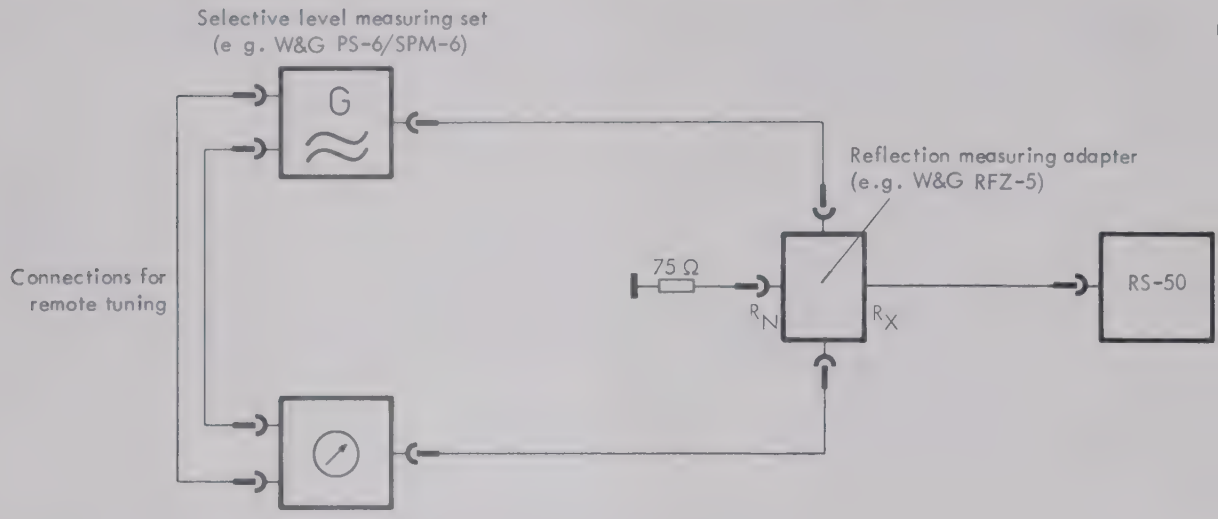


Fig. 8-3 Test configuration for measuring the return loss at the generator output

Equipment settings:

RS-50: Level 0 dBm
Leave RSB position 1 empty
Band stop filters "off"

PS-6: Frequency setting "SPM-6",
R_i=Z=75 Ohm, -42 dBm,
output I (coaxial)

SPM-6: Input coaxial, R_e=Z=75 Ohm,
0 dBm, f=20 kHz
Bandwidth 1.74 kHz,
indication range of the
meter -2.2 to +0.3 dB.

The attenuator is checked with a 20 kHz sine-wave signal. In order to feed in the signal, the band limiting filter 1 - or, if not fitted, the dummy panel - is removed. A connection is made from the PS-6 to the left plug St 306 (see Fig. 7-10) which is now accessible.

In position "0 dBm" of the course level switch S 709 on the RS-50, adjust the level at the PS-6 so that 0 dBm is indicated on the SPM-6 (reference point).

Set the course level control 709 on the RS-50 as specified in the following table. Select the appropriate sensitivity on the SPM-6 and read off the deviation from the required value.

S 709 settings

- 1 dBm	- 8 dBm
- 2 dBm	- 9 dBm
- 3 dBm	-10 dBm
- 4 dBm	-12 dBm
- 5 dBm	-22 dBm
- 6 dBm	-32 dBm
- 7 dBm	-42 dBm

Error limits (e) of the output level attenuator for each measured attenuator position: +0.24 dB.

Check of the pushbutton "+10 dB":

Reference point: 0 dBm (pushbutton "+10 dB" not depressed).
Set S 709 to position -10 dBm and depress the pushbutton "+10 dB".

Now read off the deviation with respect to the reference point.

Error limits (e): $\pm$0.24 dB.

8.1.4. Reflection at Output

See Fig 8-3 for test configuration

Equipment settings:

PS-6: Freqquency setting "SPM-6",
R_i=Z=75 Ohm, 0 dBm, output I (coaxial)

SPM-6: Input coaxial, R_e=Z=75 Ohm, bandwidth 1.74 kHz, indication range of meter -22 to +3 dB.

RFZ-5: Adjustment of the intrinsic return loss at 12.5 MHz (as described in the Operating Instructions)

RS-50: Band stop filter "off", select an unused position with S 702 (if all positions are fitted with filters, remove the band limiting filter in the selected position).

Measure the return loss at the frequency 6 kHz and 12.5 MHz. While doing so set the course level control (S 709) to the following positions:

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

0 dBm, - 1 dBm, - 11 dBm, - 21 dBm

Error limits (e): return loss: ≧ 26 dB (corresponds to a reflection factor r ≦ 0.05).

8.1.5. Noise Band with Band Limiting Filter RSB

The check of the noise power density curve when using a band limiting filter RSB described in Sections 8.1.5.1 to 8.1.5.3 can also be used to detect a defective band limiting filter. A prerequisite for this is however that the noise generator RS-50 operates correctly otherwise.

Measuring configuration:

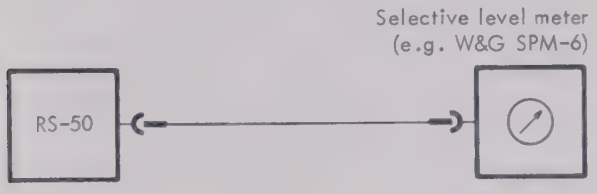


Fig. 8-4

Equipment settings:

RS-50: Level 0 dBm
Band stop filters "off"

SPM-6: Input coaxial, R_e=Z=75 Ohm, power level "dBm"
Effective noise band with 1.74 kHz
Indication range of meter -22 to + 3 dB.

The level indication P_o on the selective level meter is determined by the formula

$$p_\delta = p_\Sigma - 10 \lg \frac{\Delta f_s}{\Delta f_E}$$

Where p_δ is the component of the output level p_Σ falling within the reception band with Δf_E and Δf_s is the noise band width of the output signal. For the same output level, the indication depends on the ratio of the transmit bandwidth Δf_s to the received bandwidth Δf_E.

8.1.5.1. Frequency Response in the "Flat Area"

Observe the level indication on the selective receiver within the flat area.

Limits (e) of the level variation: +0.6 dB.

The specifications of the "flat area" of the band limiting filter used for the test can be found in Table 1-2 of the Operating Instructions for the RK-50.

8.1.5.2. Check of the Effective Band Limits

Tune the selective receiver past the limits of the flat area until the level indication drops by 3 dB. Read the frequency on the SPM-6.

The effective band limits and the permissible tolerances are also shown in Table 1-2 of the Operating Instructions for the RK-50.

8.1.5.3. Reduction of the Noise Power Density Outside the Effective Band Limits

Set up the frequencies 0.8 · f_u[1] and 1.2 · f_o on the selective level meter and determine the attenuation with respect to the flat area.

Required attenuation value: ≧ 25 dB.

8.2. BAND STOP FILTERS RSS

If a "quality test" of the band stop filter data is to be carried out, measurement in accordance with the following description is necessary.

If deviations from the prescribed attenuation curves are detected, the filters should be returned to the factory or sent to one of our service workshops for realignment.

See Fig. 8-5 for test configuration.

Equipment settings:

PS-6: Frequency setting "SPM-6", R_i=Z=75 Ohm, 0 dBm, output I (coaxial)

SPM-6: Input coaxial, R_e=Z=75 Ohm, 0 dBm, bandwidth 1.74 kHz, indication range of the meter -22 to +3 dB.

RSS: Connected in accordance with test configuration. BNC plugs with the bayonet pins removed can be used as connectors.

The attenuation curve of the band stop filter RSS being tested can be

1) For band limiting filters RSB with f_u = 12 kHz, the measuring frequency is f = 9 kHz.

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

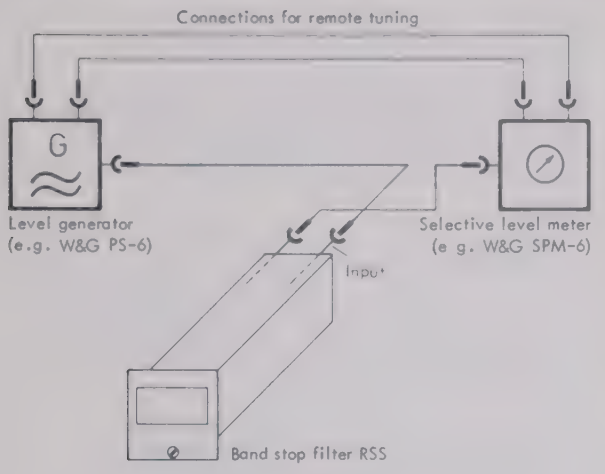


Fig. 8 5

determined from the Tables 1-3, 1-4, and 1-5 in the Operating Instructions for the RK-50.

The Table values correspond to the guaranteed error limits (e) of the band stop filters.

8.3. NOISE RECEIVER RE-50 WITH CONVERTER PLUG-INS REU

The partial errors of the measuring modes NPR and S/N specified in the Technical Data can be detected with the aid of the measurements described in Sections 8.3.1 to 8.3.4.

8.3.1. Attenuation Error of the Measuring Range Switch S 603

Measuring configuration:

Fig. 8-6

Equipment settings:

PS-6: Output I (coaxial), R_i-Z=75 Ohm, level switch -20 dBm, meter approx. -13 dBm.
Tune the frequency for a maximum indication on the RE-50 (approximately 600 Hz below or above the frequency of the selected converter plug-in REU)

RE-50. Fitted with at least 1 converter plug-in, this plug-in being selected with S 301.
Measuring mode/system switch S 501: position NPR
Reference level switch
S 602: Position -10 dBr
S 601: Position - 1 dBr
Measuring range switch
S 603: Position -20 dB

Select the output level with the fine level control so that the meter J 801 on the RE-50 indicates exactly +10 dB.

Starting from this reference point check all steps of the measuring range switch S 603. In each case adjust the output level in corresponding 10 dB steps.

Read off the attenuation error on the meter J 801 as a deviation from the +10 dB mark. If the +10 dB mark is exceeded, the switch S 601 with its 0.2 dB steps can be used as an aid for determining the error.

Error limits (e) for positions -30 to -70 dB: ±0.2 dB.
Error limits (e) for the positions -10 dB and ▼ : ±0.3 dB.

(There is also a 10 dB step between the position -10 and the reference position ▼ of the measuring range switch S 603).

8.3.2. Attenuation Error of the Reference Level Switches S 601 and S 602

Test equipment and test configuration as for Section 8.3.1.

Equipment settings as in Section 8.3.1 with the following exceptions:

PS-6: Level switch -38 dBm
RE-50: Measuring range switch S 603 to the mark "▼", reference level switch S 602: position -38 dBr, S 601. position 0 dBr.

Adjust the output level with the fine level control so that the meter J 801 on the RE-50 indicates exactly 0 dB.

Starting from this reference point, check all 2 dB steps of the switch S 602 (changing the output level in the corresponding 2 dB steps).

Read off the attenuation error on the meter J 801 as a deviation from the 0 dB mark.

Error limits (e) for switch positions
- 56 dBr...-28 dBr: ± 0.1 dB
- 26 dBr...-20 dBr: ± 0.15 dB
- 18 dBr...-14 dBr: ± 0.2 dB

-12 dBr: ± 0.25 db
-10 dBr: ∓ 0.3 dB
- 8 dBr: + 0.4 dB

Return to the reference level point (-38 dBr) and check the steps of switch S 601. The positions -2 dB and -4 dB can be checked with the aid of the 2 dB steps of PS-6, while the intermediate positions can be checked by means of the meter J 801

Error limits (e): ±0.02 dB.

A proof of this small error is only possible with restrictions using commercially available test equipment and the method described here.

The method is, however, sufficient to detect larger deviations which are to be expected in the case of a fault.

8.3.3. Attenuation Error of the Measuring Mode/System Switch S 501

Measuring configuration:

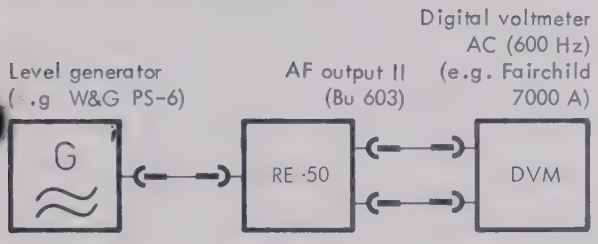


Fig. 8-7

Equipment settings:

PS-6: Output I (coaxial), R_i=Z=75 Ohm, level approx. -23 dBm, frequency set to maximum indication on RE-50 (approximately 600 Hz below or above the frequency of the selected converter plug-in REU)

RE-50: Fitted with at least 1 converter plug-in, this plug-in selected with S 301.
Measuring Mode/System switch S 501: position NPR.
Reference level switch
S 602: position - 10 dBr
S 601: position 0 dBr
Measuring range switch
S 603: position "▼"

Adjust the level at the PS-6 so that the digital voltmeter indicates exactly 2000 mV AC. Check all positions of S 501 as shown in Table 8-1.

S 501 Channels	DVM Indication mV AC	Error limits (e) (±2%) mV AC	Corresponding attenuation in dB
NPR	2000	-(reference)	0
12	2336	± 47	1.35
24	2841	∓ 57	3.05
36	3133	∓ 63	3.90
60	3681	+ 74	5.30
72	3900	+ 78	5.80
90	4325	∓ 86	6 70
120	4688	94	7.40
132	4688	∓ 94	7.40
192	5321	∓106	8 50
≧240	5572	∓111	8.90

Table 8-1

8.3.4. Scale Error in the Range -5 to +5 dB

Measuring configuration:

Fig. 8-8

Equipment settings:

PS-6: Output I (coaxial), R_i=Z=75 Ohm, output level approx. -22 dBm, frequency tuned to maximum indication on RE-50 (approx 600 Hz below or above the frequency of the selected converter plug in REU)

RE-50: Fitted with at least 1 converter plug-in REU, this plug-in being selected with S 301.
Measuring Mode/System switch S 501: position NPR
Reference level switch
S 602: position -10 dBr
S 601: position - 1 dBr
Measuring range switch
S 603: position "▼"

Adjust the output level with the fine level control so that the meter J 801 indicates exactly 0 dB.

The scale marks +2 dB, +4 dB, -2 dB, and - 4dB are tested by varying the output level in 2 dB steps.

In order to test the +5 dB and -5 dB marks, the setting of reference level

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

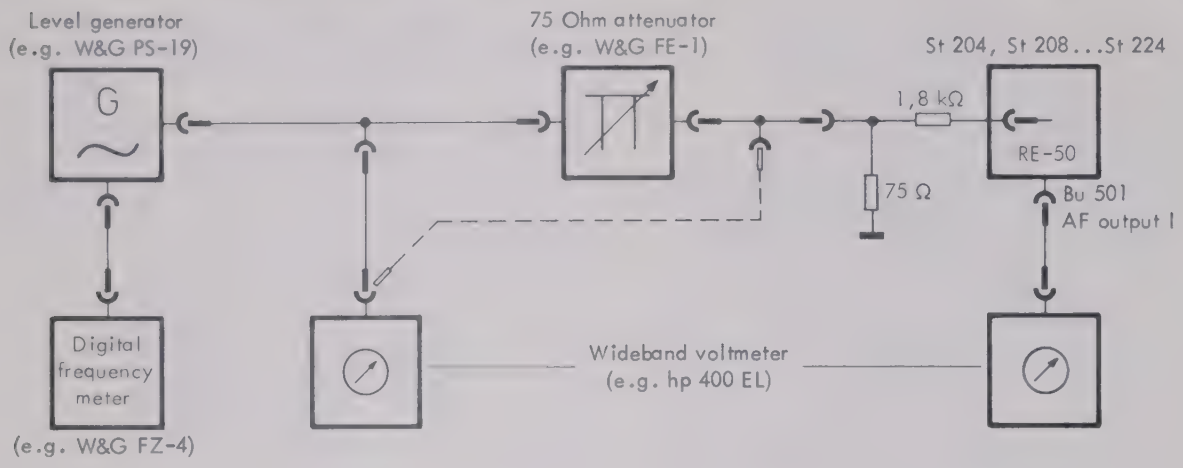


Fig. 8-9

switch S 601 is additionally changed by 1 dB.

Error limits (e) of the indication at these scale marks: ±0.3 dB.

8.3.5. Amplification and Pass Curve of the AF Filter

Verifying the pass curve of the AF filter is done for furnishing information as to the equivalent noise bandwidth of the RE-50 Receiver (for that, see paras. I.4 and 4.I.4. of " Operating Manual RK-50 ")

See Fig. 8-9 for test configuration.

Equipment settings:

PS-19: R_i-Z=75 Ohm, level approx. 19 dB, f = 600 Hz.
Attenuator: set to 0.

Amplification measurement

- The following levels should be measured with the wideband voltmeter:
  At the AF filter input: -19 dB
  At Bu 501: +14.9 dB ±0.4 dB.

Check of the pass curve

- At f = 600 Hz, insert 60 dB attenuation on the attenuator, and correct the output level so that the wideband voltmeter indicates -45 dB at socket Bu 501.
- Keep the output level constant and change the attenuation of the standard attenuator at the various test frequencies so that the wideband voltmeter at socket Bu 501 always indicates -45 dB. The difference of the settings on the standard attenuator is the filter attenuation at the appropriate frequency. The measurements are to be carried out at the following frequencies:

Test frequency	Required attenuation in dB A, B Series	C...Series
60 Hz	42 ±0.4	44 ±0.5
300 Hz	3.0 ±0.2	3.1 ±0.3
600 Hz	0.0 (reference)	0.0 (reference)
1000 Hz	3.0 ±0.5	3.0 ±0.5
2000 Hz	54.2 ±0.9	54.2 ± 0.9

Table 8-2

8.3.6. Intrinsic Noise

Terminate the input (socket Bu 201) of the RE-50 being tested with 75 Ohm.

Settings on the RE-50:

Select a converter plug-in REU with S 301.

Measuring Mode/System switch S 501:
Position S/N (any number of channels).

Reference level switch
S 602: position -56 dBr
S 601: position -4.0 dBr

Measuring range switch
S 603: position - 70 dBm0p

Read off the instrinsic noise:
-130 dBmp (sum of all switch settings) + meter indication.
Required value of intrinsic noise:
≧ -126 dBmp

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

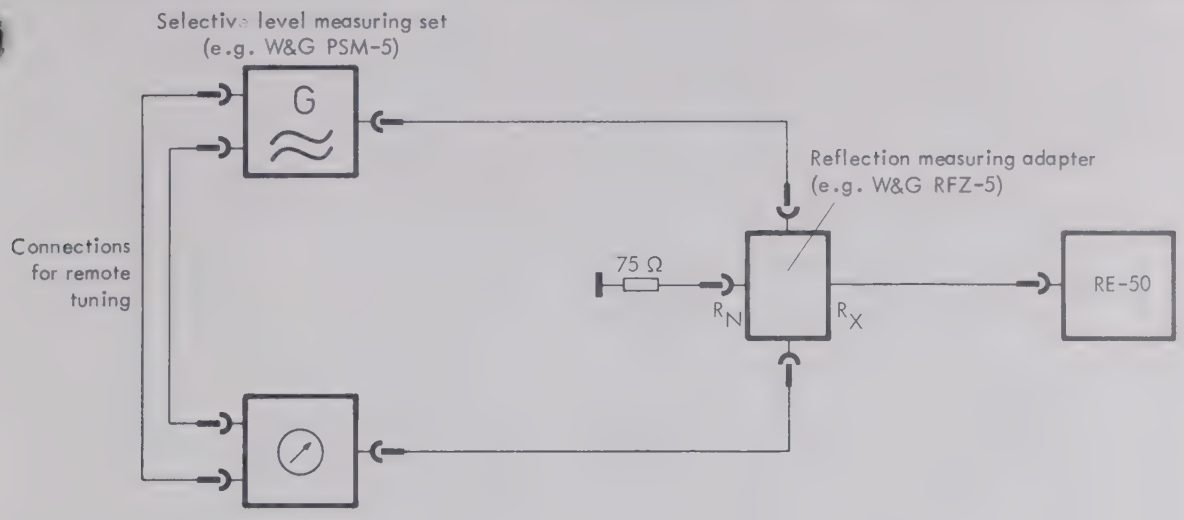


Fig. 8-10

8.3.7. Reflection at Input

See Fig. 8-10 for test configuration.

Equipment settings:

PS-6: Output I (coaxial), R_i=Z=75 Ohm, 0 dB, frequency setting "SPM-6"

SMP-6: Input coaxial, R_e=Z=75 Ohm, bandwidth 1.74 kHz, indication range of meter -22 to +3 dB.

RFZ-5: Carry out calibration at each test frequency in accordance with Operating Instructions.

RE-50: Fitted with at least 1 converter plug-in REU this plug-in being selected with S 301.
Reference level switch S 602: position -38 dBr
S 601: position 0 dBr
Measuring range switch
S 603: position -20 dB

The test frequencies are to be selected within the frequency band of the REU being used.

The return loss is read off on the SPM-6.

Set the measuring range switch S 603 to position " ▼ " and repeat the measurements.

Error limie (e): return loss: ≧20 dB (corresponds to a reflection factor r ≦0.1).

8.4. INTRINSIC NPR OF THE MEASURING SET RE-50

Measuring configuration:

Fig. 8-11

Equipment settings:

RS-50: Fitted with at least 1 band limiting filter and a band stop filter within the band, 0 dBm, band limiting filter connected, band stop filters "out"

RE-50: Select converter plug-in REU whose center frequency is equal to the band stop frequency in the RS-50, using S 301.
Measuring Mode/System switch
S 501: position "NPR"
Measuring range switch
S 603: position " ▼ "

Adjust the reference level switch S 601 and S 602 until the pointer of meter J 801 indicates " ▼ ".

8. CHECKING OF IMPORTANT TECHNICAL SPECIFICATIONS

Depress the pushbutton "band stop filters in" on the RS-50 and increase the sensitivity of the RE-50 with the aid of the measuring range switch S 603 until there is an indication on the meter J 801.

Intrinsic NPR: $-(a + \alpha)$ dB
a = setting of measuring range switch S 603

α = meter indication (upper scale).

Required value of intrinsic NPR: $\geqq$ 75 dB.

For some stop filters there are exceptions with reference to the required values (see Table 1-5 in the description of the RK-50).

9. ALIGNMENT INSTRUCTIONS

9. ALIGNMENT INSTRUCTIONS

If a repair was carried out to the measuring set or if the check of technical data in accordance with Chapter 8 detected values outside the specified error limits, this Chapter provides information on the necessary alignment measures in this case.

If not otherwise specified, the alignment operations should be carried out at room temperature (+23°C ±3°C) and after a warming up period of 20 minutes.

9.1. NOISE GENERATOR RS-50

9.1.1. Adjustment of the Supply Voltages (P 101, P 102)

Required test equipment:

1 digital voltmeter, such as Fairchild Model 7000A.

The DC voltages can be measured and aligned at socket Bu 102 on the power supply card 642-Q . Socket Bu 102 is accessible after removal of the rear cover (see Section 7.3.2).

Measurement and alignment are carried out in accordance with the following table.

Supply Voltage	Measured between	Adjust with
+15.2V ±1%	Bu102/Pin 3 and Bu102/Pin 1	P 101
-15V ±1%	Bu102/Pin 4 and Bu102/Pin 1	P 102
-24V	Bu102/Pin 2 and Bu102/Pin 1	-

Table 9-1

9.1.2. Alignment of the Reflection Loss at the Output of the Noise Source (C 227)

Measuring configuration:

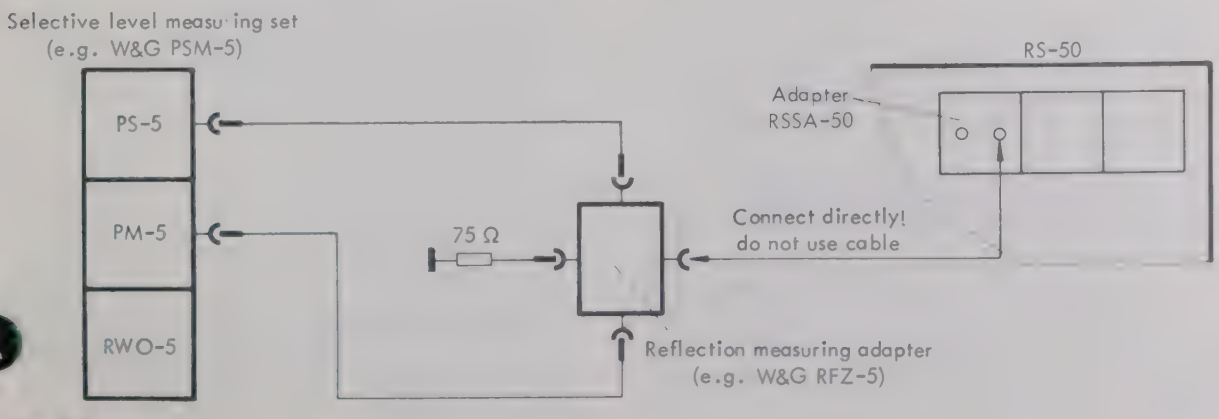


Fig. 9-1

Equipment settings:

PS-5: Output I, R_i=Z=75 Ohm, +10 dBm
PM-5: R_e=Z=75 Ohm, bandwidth 5-0 Hz, low noise
RWO-5: f_1 = 12.5 MHz, f_2 = 6 kHz

Preliminary alignment of the noise level.

- Insert adapter RSSA-50 in RSB position 1 and depress corresponding pushbutton.
- Connect input of level meter PM-5 with the adapter connection ⊷, settings on PM-5: f = 1 MHz, bandwidth 3.5 kHz, low noise.
- Adjust P 202 for approximately -54 dBm (R 233 must be fitted as otherwise only -61 dBm can be obtained).

Note:

The covers must be screwed onto the aluminium housings of the printed circuits 642-B and 642-C of the noise source.

Measurement and alignment of the return loss.

- Calibrate the intrinsic reflection of the RFZ-5 at f_1 = 12.5 MHz and +10 dBm output level (as described in Operating Instructions for RFZ-5).
- At f_1 = 12.5 MHz, determine the reference point of the indication on PM-5 using a reflection standard (a_r = 20 dB) (as described in Operating Instructions for RFZ-5).
- Connect the reflection measurement adapter directly to the adapter connection "⊷" as shown in Fig. 9-1 (RSB button 1 depressed!).
- Adjust for maximum return loss with C 227 ($a_r \geqq 28$ dB).

- Insert the adapter into RSB positions 2 and 3 in turn and measure the return loss in each case (with the appropriate RSB button depressed!).
- If the a_r values deviate from each other, align for an average value; this must in all cases be $a_r \geqq 28$ dB.
- At test frequency f_2 = 6 kHz, determine the reference point of the indication on the PM-5 and repeat the measurements (a_r values $\geqq$ 28 dB).

9.1.3. Alignment of the Noise Source Level (P 201, P 202, C 211, C 224)

Measuring configuration:

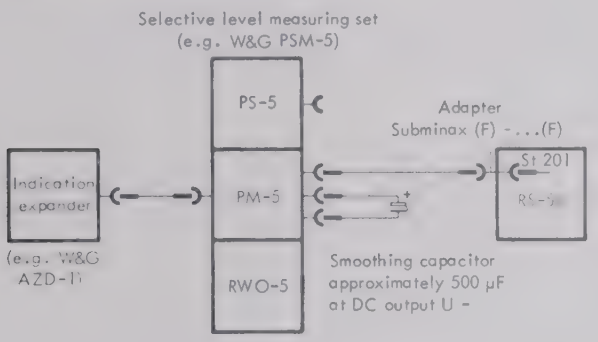


Fig. 9-2

Equipment settings:

PM-5: R_e=Z=75 Ohm, bandwidth 3.5 kHz, low noise, sensitivity -50 dBm.
RWO-5: f - 1 MHz
AZD-1: - 5 dB

Preliminary steps:

- Calibrate the level indication of PM-5 and AZD-1 (100 kHz - red mark).
- Then set up test configuration as shown in Fig. 9-2 with the specified equipment settings.

Alignment:

- Adjust P 202 for a level of -54.5 dBm (+0.5 dB) at 1 MHz.
- Adjust C 211 and C224 for the same level as above at 12.5 MHz.
- Adjust P 201 at 10 kHz for the same level as at 1 MHz.

9.1.4. Alignment Operations on the Reference Path of the Noise Level Generator (C 811)

See Fig. 9-3 for test configuration.

Equipment settings:

PS-5: Output I, R_i=Z=75 Ohm, +6 dBm
RWO-5: f = 1 MHz
RS-50: Course level switch S 709 to -20 dBm
Fine level switch S 801 to 0 dBm
S 701/III: band stop filters out
S 701/IV : released
Digital voltmeter: range 1 V DC.

Frequency response alignment of reference path:

- Set up test configuration as shown in Fig. 9-3 with attenuator 20 dB.
- At f = 1 MHz, adjust setting voltage regulator and measuring range switch of the EPM-1 for an indication of 100 mV on the digital voltmeter.
- Vary the level by ±0.1 dB, the indication must vary by approximately ± 2 mV.
- Again at 1 MHz, set up exactly 100 mV indication on the digital voltmeter with the setting voltage of the EPM-1 (Note: EPM-1 must be in regulation range, if necessary adjust with PS-5).
- At 12.5 MHz, adjust C 811 for 100 mV (EMP-1 must indicate the same level as at 1 MHz).

Frequency response of measuring amplifier:

- Set up reference point 100 mV at 1 MHz
- Measure the frequency responce at the frequency 6, 10, 100, 500 kHz, 5, 10, 12.5 MHz
- Permissible tolerance: ±3 mV (at 6 kHz: -6/+3 mV).

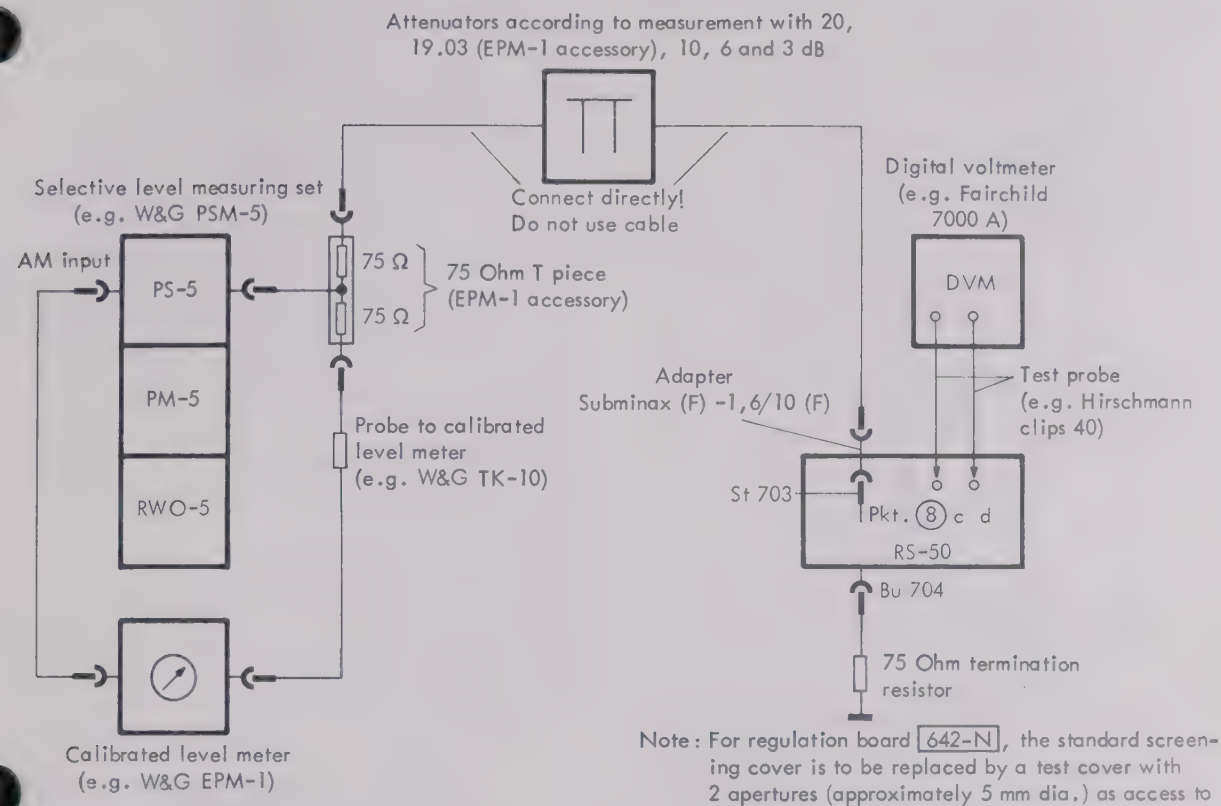
Frequency response of fine level switch S 801:

- Set up an indication of 100 mV on the digital voltmeter at 1 MHz and with the fine level control in the position 0 dBm. After this adjust the fine level switch S 801 from 0 to -1 dBm and read and record the voltage on the digital voltmeter in each switch setting.
- At 5 MHz, turn S 801 back from -1 to 0 dBm and repeat the measurements. The results should again be recorded.
- At 12.5 MHz, turn S 801 from 0 to -1 dBm and measure at each switch setting.
- Permissible tolerance: the values at 5 and 12.5 MHz may deviate by a maximum of ± 2 mV from the values obtained in the same switch positions at 1 MHz.

Frequency response of attenuator 4:

- Set fine level control S 801 to position 0 dBm.

9. ALIGNMENT INSTRUCTIONS


Attenuators according to measurement with 20, 19.03 (EPM-1 accessory), 10, 6 and 3 dB
Connect directly! Do not use cable
Selective level measuring set (e.g. W&G PSM-5)
AM input
PS-5
PM-5
RWO-5
75 Ω
75 Ω
75 Ohm T piece (EPM-1 accessory)
Probe to calibrated level meter (e.g. W&G TK-10)
Calibrated level meter (e.g. W&G EPM-1)
Digital voltmeter (e.g. Fairchild 7000 A)
DVM
Adapter Subminax (F) -1,6/10 (F)
Test probe (e.g. Hirschmann clips 40)
St 703
Pkt. (8) c d
RS-50
Bu 704
75 Ohm termination resistor

Note: For regulation board 642-N, the standard screening cover is to be replaced by a test cover with 2 apertures (approximately 5 mm dia.) as access to the test points (8) c and d. After alignment, the standard cover is to be refitted.

Fig. 9-3

- Set up an indication of 100 mV on the digital voltmeter at 1 MHz and in the specified switch positions of the course level switch S 709, using the adjustment voltage and the measuring range switch of the EPM-1. Then measure at the frequencies 5 and 12.5 MHz; in the test configuration shown in Fig. 9-3, the attenuators are to be exchanged as shown in Table 9-2 depending on switch settings of S 709:

Switch Setting S 709	Attenuator to be used
- 20 dBm	20 dB
- 19 dBm	20 dB
- 18 dBm	19.03 dB
- 16 dBm	10 dB + 6 dB
- 12 dBm	10 dB + 3 dB

Table 9-2

- Permissible tolerance, with reference to the corresponding values at 1 MHz: ±3 mV.

Frequency response of attenuator 3:

- Measure at 1,5, and 12.5 MHz and in the following switch positions of the course level switch S 709.

Switch Setting S 709	Attenuator to be used
- 10 dBm	10 dB
0 dBm	Connect St 703 directly to T piece

Table 9-3

- Permissible tolerance, with respect to the corresponding values at 1 MHz: ±3 mV.

9.1.5. Frequency Response Alignment of the Whole Unit with Noise at Minimum Amplification (C 424, P 201)

Before carrying out the alignment operations, the intrinsic frequency response of the PM-5 is to be determined. For this purpose, the test configuration shown in Fig. 9-4 is used.

9. ALIGNMENT INSTRUCTIONS

Measuring configuration:

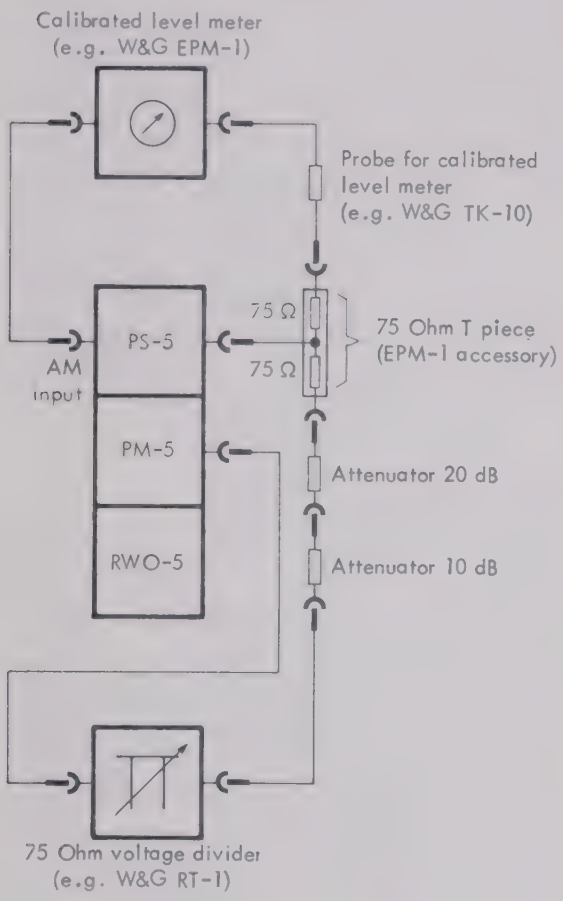


Fig. 9-4

Equipment settings:

PS-5: Output I, R_i=Z=75 Ohm, + 6dBm
RE-5: R_e=Z=75 Ohm, -90 dBm, bandwidth 3.5 kHz, low noise.
RWO-5: 1 MHz
RT-1: Approx. 50 dB (without basic attenuation a_o).

- Adjust indication on PM-5 to 0 dBm at at MHz with RT-1.
- Determine the intrinsic frequency response of the PM-5 at the frequency 6,10,20, 50,100, 500 kHz, 1,2,5,10 and 12.5 MHz

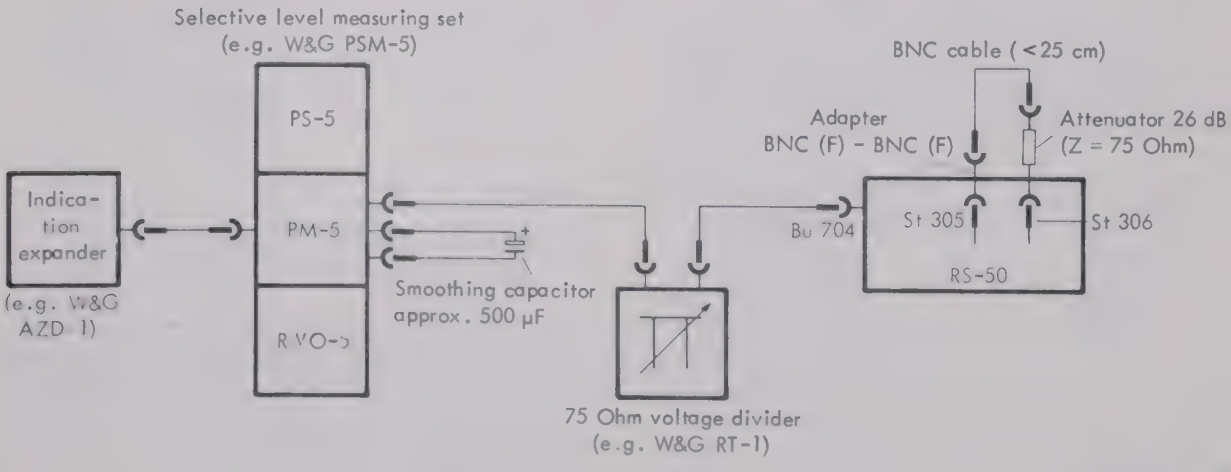
Frequency response alignment of the noise generator.

See Fig. 9-5 for test configuration.

Equipment settings:

PM-5: R_e=Z=75 Ohm, -90 dBm, bandwidth 3.5 kHz, low noise
RWO-5: f = 12.5 MHz
AZD-1: O dB
RT-1: Approx. 20 dB (without basic attenuation a_o)
RS-5: Cross level switch S 709 to -20 dBm
Fine level switch to S 801 to 0 dBm
S 701/III: band stop filters out
S 701/IV : released
Pushbutton for RSB position 1 depressed.

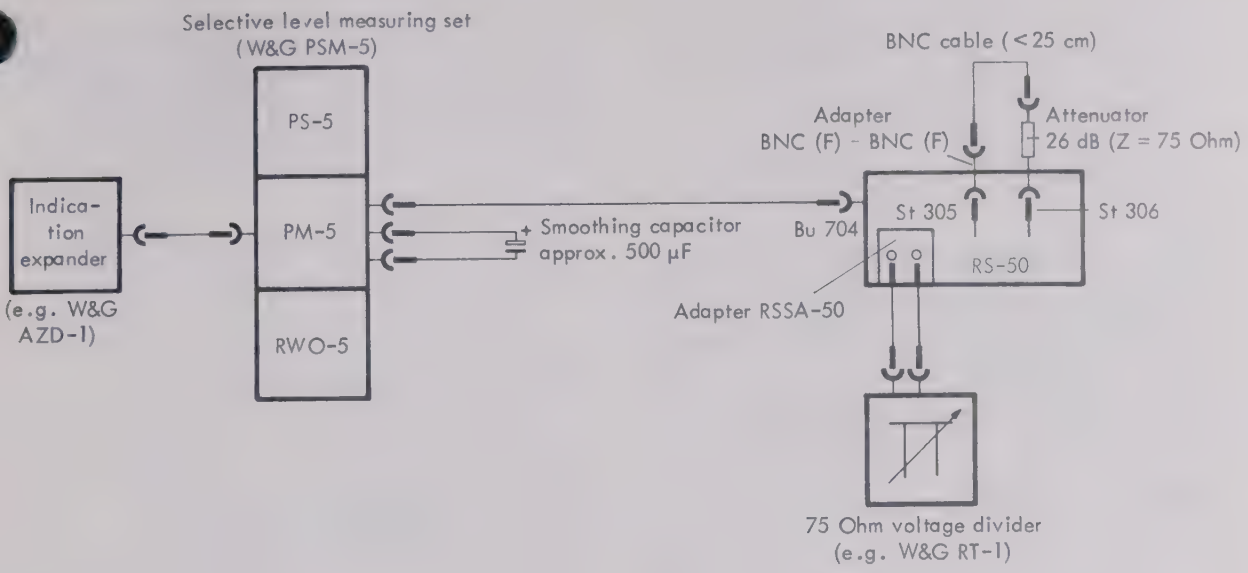
- At 12.5 MHz, set up "0 dB" on AZD-1 with RT-1.
- At 1 MHz, adjust C 424 for the same level (if the adjustment range is not sufficient, use trimmers C 211 and C 224 as well).



Note: Plugs St 306 and St 305 are t connections of RSB position 1 (see also Fig. 7-10)

Fig. 9-5

9. ALIGNMENT INSTRUCTIONS



Note: Plugs St 306 and St 305 are the connections of RSB position 1 (see also Fig. 7-10)

Fig. 9-6

- At 10 kHz, adjust P 201 for the same level as at 1 MHz.

Note:
When aligning, take the intrinsic frequency response of PM-5 into account.

Check of the frequency response:

- The frequency response is to be checked at the frequencies 6,10,20, 50, 100, 500 kHz and 1,2,5,10, 12.5 MHz.
- Permissible tolerances:
  1 to 10 kHz: +0.043 dB
  10 kHz to 1 MHz: 0.023 dB
  1 to 12.5 MHz: ±0.013 dB

Frequency response of attenuator 1 and attenuator 2

- Determine the reference frequence response at position -20 dBm of the course level switch S 709, measuring frequencies as above, reference point is f = 1 MHz.
- Attenuator 1
  20 dB: see reference frequency response
  10 dB: course level switch S 709 to -10 dBm
  add 10 dB attenuation on RT-1
  0 dB: course level switch S 709 to 0 dBm
  add 10 dB attenuation on RT-1
  Attenuator 2
  0 dB: see reference frequency response
  10 dB: course level switch S 709 to -30 dBm
  10 dB less attenuation on RT-1
  20 dB: course level switch S 709 to -40 dBm
  10 dB less attenuation on RT-1
  30 dB: course level switch S 709 to -50 dBm
  10 dB less attenuation on RT-1
- Permissible tolerances are specified as above.

Note:
When determining the frequency responses, the intrinsic frequency response of the PM-5 is to be taken into account.

9.1.5.1. Check at Maximum Amplification

See Fig. 9-6 for test configuration.

Equipment settings:

PM-5: R_e=Z=75 Ohm, -60 dBm, bandwidth 3.5 kHz, low noise

RS-5: Course level switch S 709 to -20 dBm
Fine level switch S 801 to 0 dBm
Button for RSB position 1 depressed
S 701/III: band stop filters in
Stop filter preselection button: correct button for the position of adpater RSSA-50 depressed

RT-1: 10 dB (without basic attenuation a_o)

- Determine the frequency response at the frequencies 6,10,20,50,100 500 Khz and 1,2,5,10,12.5 MHz. Reference value: 1MHz
- Permissible tolerances:
  1 to 10 kHz: +0.043 dB
  10 kHz to 1 MHz: +0.023 dB
  1 to 12.5 MHz: ±0.013 dB

Note:
Before determining the frequency response, the intrinsic frequency response of the PM-5 is to be recorded as shown in Fig. 9-4 at a sensitivity of -60 dBm and taken into account accordingly.

9.1.6. Level Alignment with Noise (P 801)

Measuring configuration:

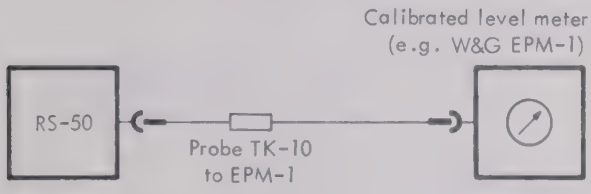


Fig. 9-7

Equipment settings:

RS-50: Course level switch S 709 to 0 dBm
Fine level switch S 801 to 0 dBm
Insert and switch on band limiting filter RSB-316/12360
S 701/III: band stop filters out

EPM-1: Calibrate before aligning to 0 dBm

Level alignment:
- Adjust P 801 for exactly 0 dBm on the EPM-1 (if necessary change R 808 - P 801 should be approximately in the center of its range after alignment).

9.2. NOISE RECEIVER RE-50

9.2.1. Adjustment of the Supply Voltages (P 101, P 102)

Necessary test equipment:

1 digital voltmeter, such as Fairchild Model 8000 A.

The DC voltages can be measured and aligned at the 2 x 10 pole socket on the power supply board 644-A

The 2 x 10 pole connector is to be removed from the socket for measurement.

Measurement and alignment are carried out in accordance with the following table.

Supply Voltage	Measured between	Align with
+12V ±1%	Pin 5,6,7,8,9, or 10 to Pin 4,D,E,F,H,J	P 101
-20V ±1%	Pin 1,2,3,A,B or C to Pin 4, D,E,F,H,J	P 102

Table 9-4

9.2.2. Alignment of the Meter Indication (P 803, P 807)

Any scale error which is detected, for example, by the measurement described in Section 8.3.4 can be rectified with the alignment described in the following Section.

Measuring configuration:

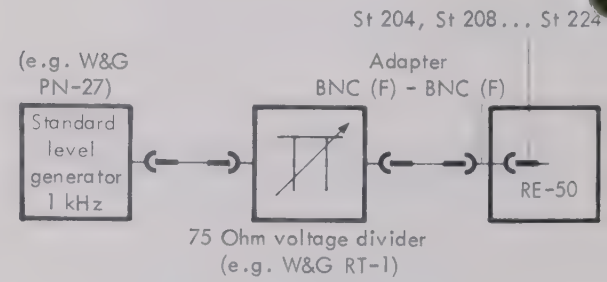


Fig. 9-8

- Connect the -20 dB output of the standard level generator to the RT-1
- Adjust the RT-1 so that the noise receiver indicates 0 dB (reference mark)
- Change the connection on the standard level generator to the outputs -10 dB, -30 dB, and -40 dB in turn
- The indication on the RE-50 must be +10 dB ±0.2 dB (align with P 807), -10 dB ±0.2 dB, and -20 dB ±0.2 dB (align with P 803). The alignment must be carried alternately.
- After this, the calibration of the RE-50 must be checked in accordance with Section 9.2.4.

9. ALIGNMENT INSTRUCTIONS

9.2.3. Alignment of Board 643-M Rectifier, Quasi Effective Value Generator, Logarithmer, and Indication (P 801...P 809)

The board 643-M must be removed from the unit for complete alignment (see also Section 7.4.4).

The board is to be plugged into the test adapter and the following test configurations set up:

Measuring configuration:

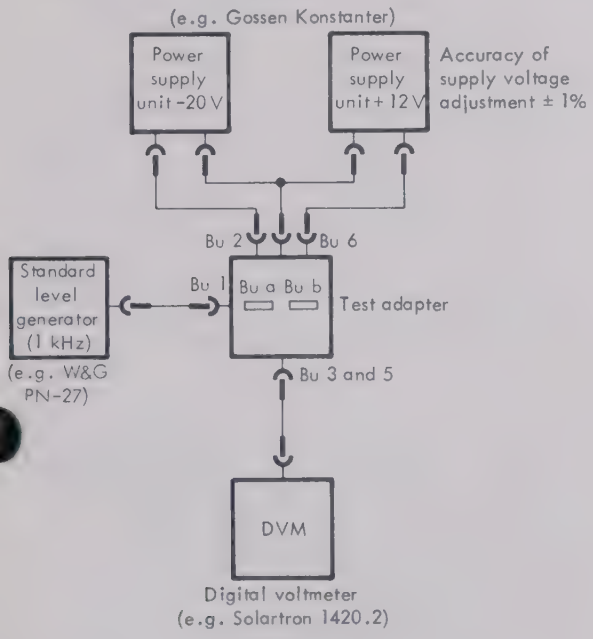


Fig. 9-9

The electrical details of the test adapter are shown in Fig. 9-10.

Amphenol 1 x 10 pole (series 225) sockets are to be used for insertion of the board 643-M .

The plug strip a on board 643-M belonging to socket a is on the left (when viewed from the component side). The contacts are numbered as shown in Fig. 9-11.

Alignment at room temperature (+23°C).

- Switch position 1 of the test adapter:
  Disconnect the standard level generator from the input of the test adapter and adjust P 801 so that the digital voltmeter indicates ≦ +0.2 mV.
- Switch position 3 of the test adapter:
  Connect the -20 dB output level from the standard level generator to the input of the test adapter; adjust P 802 for 10 mV ±0.2 mV indication.
- Switch position 2 of the test adapter:
  Disconnect the standard level generator from the input of the test adapter; adjust P 804 so that the digital voltmeter indicates 0... + 0.05 mV.
- Switch position 4 of the test adapter:
  Connect the -20 dB output level of the standard level generator to the input of the test adapter; adjust P 805 so that the digital voltmeter indicates ≦ +2 mV. If necessary decrease or increase the value of R 823.
- Switch position 5 of the test adapter:
  Connect the 0 dB output of the standard level generator to the input of the test adapter; adjust P 809 so that the digital voltmeter indicates ≦ ±0.5 mV.
- Switch position 6 of the test adapter:
  Connect the -20 dB output of the

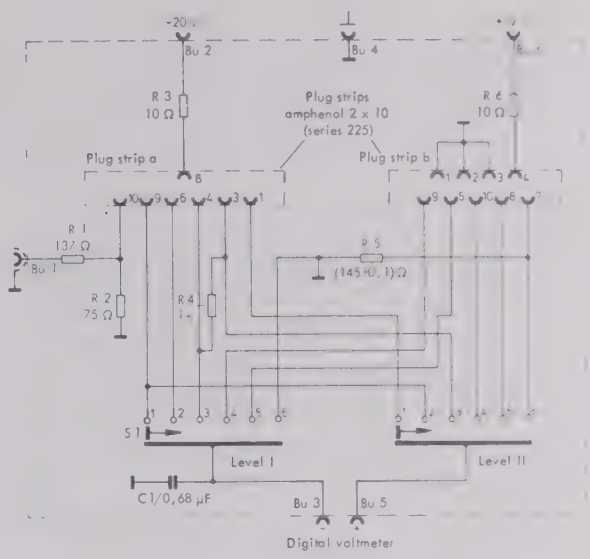


Fig. 9-10 Circuit of the test adapter

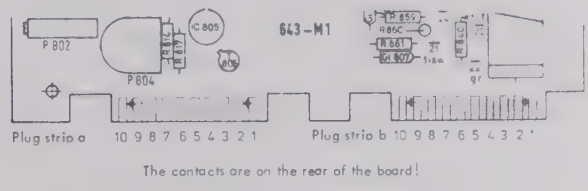


Fig. 9-11 Partial view of board 643-M

9. ALIGNMENT INSTRUCTIONS

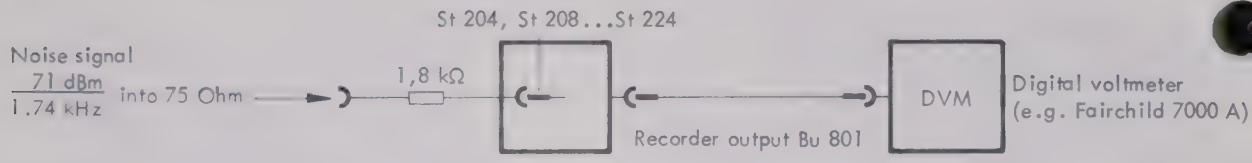


Fig. 9-12

standard level generator to the input of the test adapter; adjust P 803 so that the digital voltmeter indicates < +0.1 mV.
After this connect the +10 dB output to the input of the test adapter; adjust P 807 so that the digital voltmeter indicates 87.0 mV ±0.1 mV.

Alignment at ambient temperature +50°C (in heating cabinet, heating time ≧1 hour).

- Switch position 6 of the test adapter:
  Connect the -20 dB output of the standard level generator to the input of the test adapter and adjust P 806 so that the digital voltmeter indicates < ±0.1 mV.
  Then connect the +10 dB output to the input of the test adapter; adjust P 808 so that the digital voltmeter indicates 87.0 mV ±0.1 mV.

After installing the board 643-M in the noise receiver, calibration in accordance with Section 9.2.4 is to be carried out.

9.2.4. Calibration of the Noise Receiver (P 802, P 803)

A prerequisite for calibration of the noise receiver is a calibrated noise signal (white noise) with a level of -75 dBm into 75 Ohm, with reference to a bandwidth of 1.74 kHz. Absolute accuracy and frequency response of the noise signal must be of the order of ±1 to ±10 mB.

The noise signal is to be connected to the input of the AF filter via a 1.8 kOhn resistor.

See Fig. 9-12 for the test configuration.

Settings on the RE-50:
Reference level switch
S 601: 0 dBr
S 602: -40 dBr
Measuring range switch
S 603: -60 dBm0p/dB
Measuring Mode/System switch S 501: S/N

Calibration
- Before starting the calibration, check the mechanical zero of the meter.
- Adjust the amplification with P 802 so that the meter indicates 0 dB
- Set the measuring range switch S 603 to -40 dBm0p/dB; if the meter does not now indicate - 20 dB, adjust with potentiometer P 803
- After this check the setting at 0 dB again
- In the position -70 dBm0p/dB of the measuring range switch S 603, the meter must indicate full scale deflection +10 dB ±0.2 dB
- A voltage between 0 and 175...300 mV can be measured with the digital voltmeter between Pins a and c of the 3 pole TF socket of the recorder output Bu 801. This voltage can be adjusted with potentiometer P 810 (from Series D onwards: with P 811)

Note:
In the factory, special test equipment is used in addition to commercially available equipment for generation of the noise signal with the required accuracy. For this reason, the description of the calibration operation provides no details of generation of the noise signal, in order to avoid placing unnecessary restrictions on the service engineer. However, in order to show one possibility of generating this noise signal, the following paragraphs describe the test configuration used in the factory.

Generation of the noise signal for calibration of the RE-50:

See Fig. 9-13 for test configuration.

Equipment settings:

RG-1: Pushbutton "white noise 16 Hz ...22 kHz, external filter" depressed
EPM-1: 0 dBm ±0.2 dBm R_i=75 Ohm

Note:
Care should be taken that only a completely discharged electrolytic capacitor is connected in parallel to the meter and that the polarity is correct!

9. ALIGNMENT INSTRUCTIONS

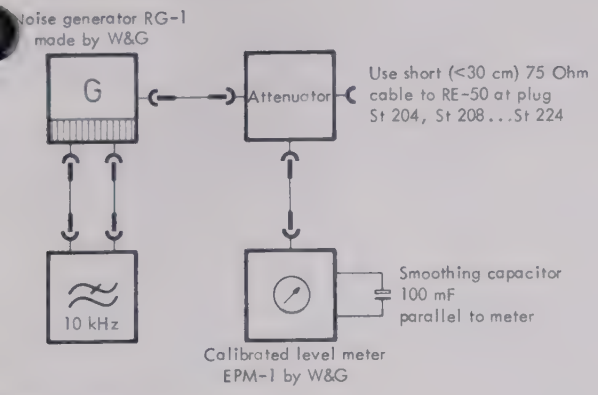


Fig. 9-13

The noise band 16 Hz...22 kHz generated by the noise generator RG-1 has a flat frequency response in the range 50 Hz...10 kHz. This range is specifically cut out with the aid of the 10 kHz low-pass filter and connected to the input of the standard attenuator. A level of 0 dBm into 75 Ohm, referred to a bandwidth of approximately 10 kHz, is set up on the calibrated level meter EPM-1 which is connected to the input of the standard attenuator. The standard attenuator attenuates the noise signal, taking into account the bandwidth of 1.74 kHz which is evaluated by the noise receiver RE-50, to -71 dBm into 75 Ohm.

Noise generator RG-1:
The frequency response of the RG-1 is to be checked before starting the calibration operation. The required accuracy of the noise calibration level is ensured only when the RG-1 has the following frequency response:

1 kHz: 0 (reference)
8 kHz: -0.11 dB +0.03 dB
10 kHz: -0.15 dB $\mp$0.03 dB

The frequency response is checked with the following test configuration.

Measuring configuration:

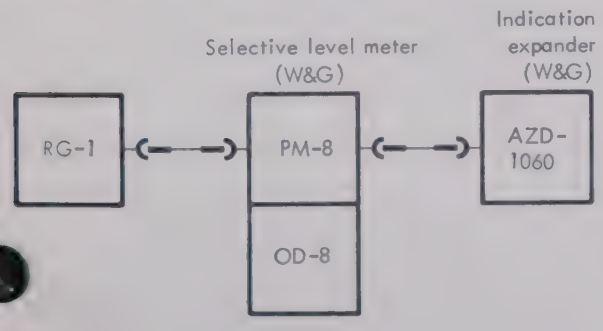


Fig. 9-14

Equipment settings:

RG-1: White noise 16 Hz...22 kHz, 0 dB
PM-8: Symmetrical input, R_e=Z=600 Ohm -10 dB, bandwidth 2.74 kHz, low noise
AZD-1060: +1.5...+6V,τ =30 s

10 kHz low-pass filter:
The 10 kHz low-pass filter (Z = 600 Ohm) is connected as an external filter in the signal path of the noise generator and cuts out a defined band in the flat frequency response sector. The resulting power loss can be corrected by means of the attenuation equalization switch on the noise generator.

The low-pass filter is dimensioned as follows:

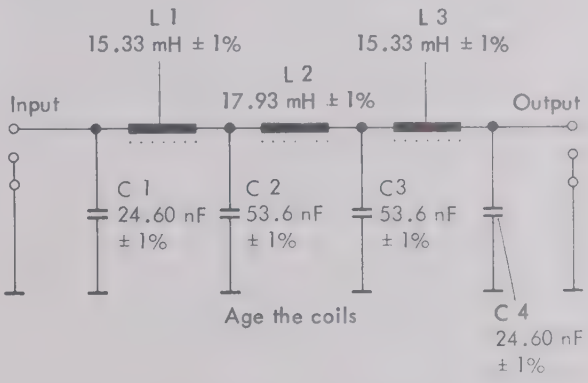


Fig. 9-15 Circuit diagram of the 10 kHz low-pass filter

As the bandwidth of the low-pass filter affects the calibration value of the standard attenuator (see below) and exact determination of the effective limit frequency of the low-pass filter is necessary.

- Determination of the effective limit frequency of the 10 kHz low-pass filter.

If the low-pass filter is replaced by a real i.e. slowly increasing, attenuation by an ideal low-pass filter with a rapidly rising attenuation at the frequency at which the sum noise powers at the output of the real and ideal filters are identical, then this frequency corresponds to the effective limit frequency of the real low-pass filter.

The flank of the ideal low-pass filter is to be positioned so that the added and removed powers are equal. To do this, the interesting area

of the real filter flank is squared and the area below this curve, starting from the measuring frequency f_{m0} , which must still be in the pass range is determined. The effective limit frequency can be determined by converting this area into a rectangual (Figs. 9-16 and 9-17).

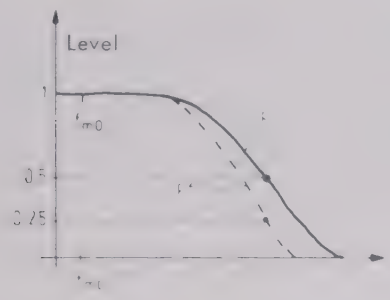


Fig. 9-16

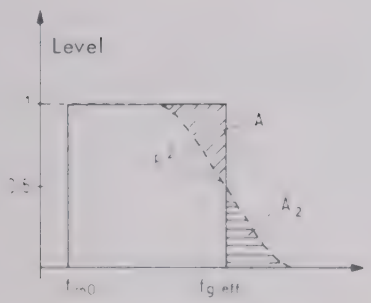


Fig. 9-17

Practical method:
After determining the low-pass attenuation curve (e.g. with the level measuring set PSM-8 made by W & G) the filter flank is divided, starting at f_{m0}, into equal frequency steps up to a stop attenuation of 30 dB.

At the frequencies f_{m0}, $f_{m1}...f_{mi}$, the level values are then read from the curve and recorded as voltage values with reference to the value at f_{m0} .

After this the values are squared (≙ power).
Comparison example in Fig 9-18.

The effective limit frequency of the low-pass filter is now calculated with the aid of the formula

$$f_{g,rms} = f_{mo} - 0.5\,\Delta f + \Delta f \,.\, S$$

$$\boxed{f_{g,\,rms} = f_{mo} + \Delta f\,(S - 0.5)}$$

S sum of the squared level values

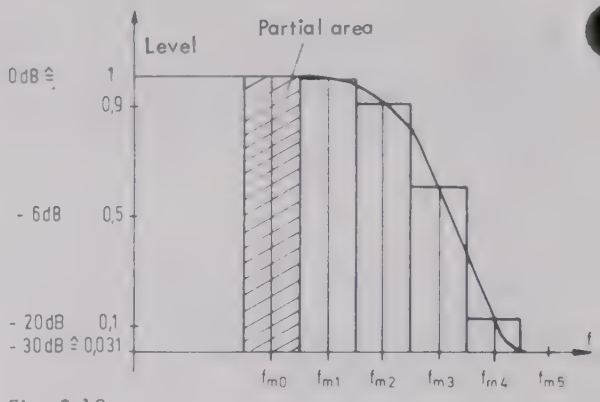


Fig. 9-18

The following values are obtained:

Level value U_1 at f_{m0}:	1	
Squared level value U_1^2 :		1
Level value U_2 at f_{m1}:	0.99	
Squared level value U_2^2 :		0.98
Level value U_3 at f_{m2}:	0.90	
Squared level value U_3^2 :		0.81
Level value U_4 at f_{m3}:	0.60	
Squared level value U_4^2 :		0.36
Level value U_5 at f_{m4}:	0.12	
Squared level value U_5^2 :		0.0144
Level value U_6 at f_{m5}:	0.01	
Squared level value U_6^2 :	approx. 0	
	Sum S = 3.16	

Standard attenuator:
The circuit of the standard attenuator has the following appearance:

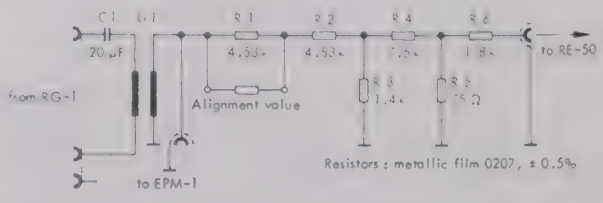


Fig. 9-19 Circuit diagram of the standard attenuator

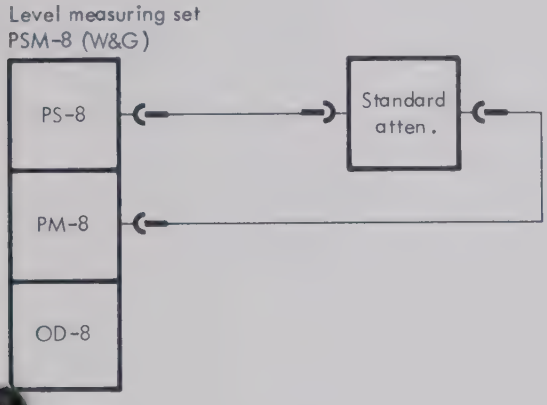
The transformer U1 (limit frequency 30 Hz) matches the 75 Ohm input resistance of the calibrated level meter to the 600 Ohm output of the noise generator and prevents a ground loop between the noise generator and the test object (RE-50).

s the output of the RG-1 can have a
C current component, the isolating
capacitor C 1 (2 x 10 µF capacitors)
was installed.

Determination of the alignment value:
The test configuration shown in Fig.
9-20 is used for determination of the
alignment value.

Equipment settings:

PS-8: R_i = 600 Ohm, o dB
PM-8: R_e = 75 Ohm bandwidth 1.74 kHz
OD-8: f = 1 kHz.



g. 9-20

- With the aid of the alignment value, an indication of

$$p = -71\ dB + 10\ lg\ \frac{\Delta f_s}{1.74\ kHz}$$

is to be set up on the receiver, Δf_s being made equal to the effective limit frequency of the 10 kHz low-pass filter.

100 µF Smoothing Capacitor
The calibrated level meter EPM-1 is not capable of integrating the low frequency noise spikes in the relatively narrow noise band. The result is a noise indication which varies by ±2%. As the EPM-1 is used as a reference standard in this measurement, the indication is damped by a 100 µF capacitor connected parallel to the meter and the indication variations now lie by approximately 0.2%. The settling time of the instrument is approximately 1 minute due to this measure. Great care should be taken that only a completely discharged electrolytic capacitor is connected in parallel to the meter and that the polarity is correct.

10. DESCRIPTION OF FUNCTION

10. DESCRIPTION OF FUNCTION

In the following sections, the function of the various unit assemblies are described on the basis of the circuit diagrams in the Appendix. It is assumed that the basic method of operation of the units in the measuring set RK-50, as described in Chapter 4 of the Operating Instructions, are already known.

10.1. NOISE GENERATOR RS-50

10.1.1. Noise Source (2)

The noise source consists basically of the thermally noisy resistor R 201 whose voltage is amplified by a 4 stage amplifier. In order to keep the noise component of the transistor small, the 1st stage is fitted with pnp transistors 2N 3251. T 201 has minimum noise when it has a source resistance of approximately 1 kOhm and a collector current of I_C = 1 mA. This impedance converter is followed by the actual amplifier stage T 202 and the emitter follower T 203. The working point of the whole stage is held via R 210, R 202, and R 201.

R 202/C 201 emphasise the noise at low frequencies. An alignment is then carried out by reducing the level by means of C 203P 201 together with C 206. L 201 compensates for the drop at high frequencies. GL 201 protects the base-emitter path of T 202 in case a supply voltage fails.

The following stages are constructed in a manner similar to the first one.

Frequency alignment in the upper range is carried out with C 211 and C 224.

Gl 203 and Gl 204 protect the tantalum electrolytic capacitors against unpermissible reverse polarity in the case of a supply voltage failure.

The reflection factor at the output of the noise source is aligned with C 227. In order to keep the reflection factor small, the transistor BFY 90 was used for T 212 (high f_T).

10.1.2. Band Switch (3)

The band switch permits selection of one of the 3 plug-in band limiting filters RSB. The line inductances are aligned to an impedance of 75 Ohm by means of printed capacitors and a capacitor on each input and output. The relay cards used here are identical to those of the stop filter switch.

The necessary crosstalk attenuation of approximately 70 dB, which is intended to prevent the area outside the band from being refilled with noise, is attained by disconnecting the line path at both sides when switching and connecting it to ground.

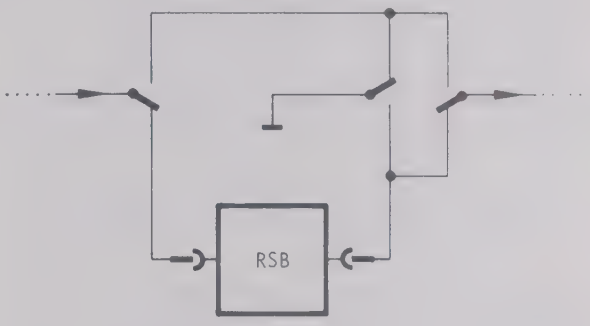


Fig. 10-1 Band switching principle

10.1.3. Adjusting Amplifier (4)

The adjusting amplifier equalizes the attenuation which is caused by

- The fine level switch.....0....-1 dB
- The 1 dB step of the level switch.....+9...0 dB
- The basic attenuation of the stop filters and the +10 dB scale shift.....+12...0 dB
- Tolerance and drift.....+ 2...-2 dB

The overall variation range of the adjusting amplifier is thus

..... +23...-3 dB

The adjusting amplifier consists of 3 adjustable amplifier stages and 1 fixed stage at the output. The amplifier stages are identical in function to those of the noise source. The amplification variation is implemented by varying the collector current and thus the working point of T 402, T 405, and T 408. The effect of the control voltage on the 3 adjustable stages is not uniform; it is staggered by means of R 409, R 422, and R 435 in order to keep the distortion low. Gl 401....Gl 406 serve as reverse polarity protection in the case of a supply voltage failure. Gl 407 increases the dynamic range of the last stage.

A frequency response emphasis from approximately 7 MHz upwards is attained by means of R 455/C 431 and is necessary for compensation of a frequency response step in the final amplifier.

10. DESCRIPTION OF FUNCTION

Frequency alignment of the noise level in the whole unit is carried out with C 424.

10.1.4. Attenuator 1, Driver, and Final Amplifier (5)

Further processing of the signal after the adjusting amplifier is carried out in attenuator 1. This is constructed as a simple resistance attenuator (R 501...R 503) and is switched by means of the reed relays Rel 501...Rel 503. It permits a level reduction by 0, 10, or 20 dB.

The resistors R 504...R 506 complement the internal resistance to a constant value in each case.

The diodes Gl 501...Gl 503 prevent voltage spikes when the relays are de-energized. The series resistors R 538...R540 are installed for protection of the relay windings.

The signal is passed via C 504 to the driver T 503 which is practically only an isolating stage.

The output stage consists of a single stage amplifier preceeded by emitter followers for correct phase driving of the final transistors (T 506, T 507). The final amplifier is designed for amplification of V = 16 dB and has a 75 Ohm output.

The complex filtering of the emitters of the final transistors (R 529, R 536, C 516, C 521 and R 530, R 537, C 517, C 522) is necessary here as an AC voltage of above 1 V is present at the emitter resistors R 531 and R 532 at maximum output and a feedback via the power supply must be prevented.

The RC combinations R 533/C 518 and R535/C 519 increase the frequency response at frequencies from 7 MHz upwards.

An inductance of approximately 0.1 µH is necessary in order to improve the return loss. This inductance is in the form of a printed circuit.

As the DC output voltage at R 534 depends on the output transistors - theoretically it is "0 V" - and thus varies around 0 V, it is at any time possible to reverse the polarity of the coupling capacitors C 520. Special conditions must however be observed with respect to reverse polarity and operation with AC voltage for tantalum electrolytic capacitors. For this reason, the circuit makes use of the facility of connecting 2 tantalum capacitors with reversed polarity in series (back to back circuit).

The diodes Gl 506 and Gl 507 protect the circuit against reverse polarity of the supply voltage.

The filtering (R 521/C 514 and R 525/ C 515) for the driver transistors T 504 and T 505 was provided separately in order to obtain the necessary supply voltage for maximum output on the final transistors.

The voltage divider - consisting of R 522...R 524 - determines the working point of the final amplifier.

10.1.5. Stop Filter Switch (6)

The stop filter switch permits selection of any combination of the 6 plug-in band stop filters RSS.

The construction and method of operation is similar to that of the band switch. The requirements for crosstalk attenuation are however

Operating mode	Socket Bu 701		Funktion		
	46	48	Level	Band limiting	Band stop filters
Manual control	H	H	Manually controlled with S 709	Manually controlled with S 702/I...III	Manually controlled with S 703...S 708 and S 701/III
Partial remote control	H	L	Manually controlled with S 709	Manually controlled with S 702/I...III	Remotely controlled by Bu 701
Complete remote control	L	-	Remotely controlled by Bu 701	Remotely controlled by Bu 701	Remotely controlled by Bu 701

Table 10-1 Operating modes of Noise Generator RS-50

10. DESCRIPTION OF FUNCTION

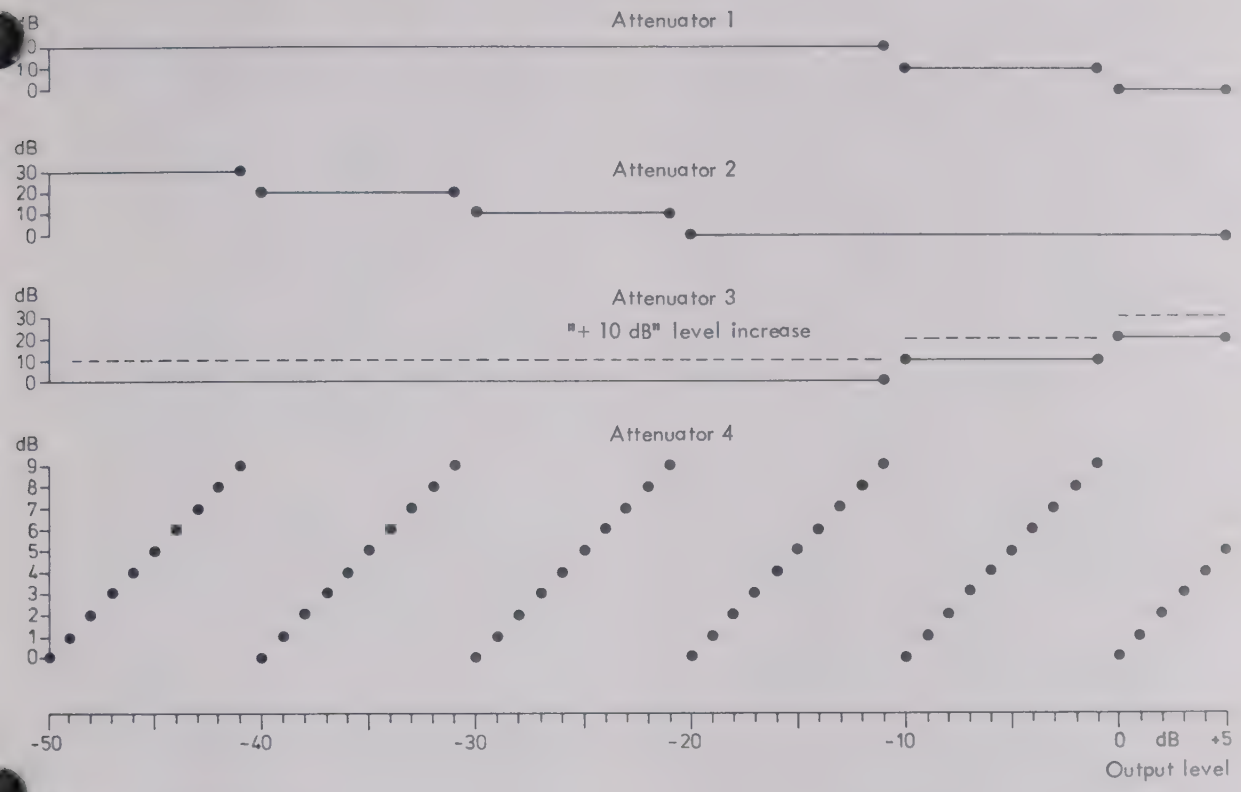


Fig. 10-2 Attenuator control

considerably higher in this case (>100 dB). This is attained by means of additional screening between the various relay cards.

10.1.6. Logic Circuit, Level Control, Attenuators 2, 3, and 4 (7)

In the description of assembly (7), a distinction must be made between the 3 possible operating modes of the noise generator RS-50:

- Manual operation
- Partial remote control, i.e. control of the generator by the receiver RE-50
- Complete remote control by a programme generator.

Selection of one of the 3 operating modes of the RS-50 generator is made by connection of a low signal to contact 46 or 48 of the remote control socket Bu 701. The operating modes "remote control" have priority over manual control.

The 0.1 dB steps of the fine level switch S 801 and the 10 dB level increase with pushbutton S 701/IV cannot be remotely controlled.

10.1.6.1. Manual Control

Level Control

Adjustment of the output level in 1 dB steps is carried out with the aid of the attenuators 1, 2, 3, and 4, which are controlled as shown in Fig. 10-2 by the course level switch S 709 and a diode matrix.

As can be seen from Fig. 10-2, attenuators 1 and 3 are operated in opposite directions. This is done so that the level at the generator output can be varied without changing the amplification of the adjusting amplifier (4). If, for example, the attenuation of attenuator 1 is increased by 10 dB and that of attenuator 3 is simultaneously reduced by 10 dB, the overall attenuation of the control circuit remains the same, as does the amplification of the adjusting amplifier, but the level of the level circuit output signal, i.e. the level at the generator output, drops by 10 dB.

It can also be seen in Fig. 10-2 that a greater attenuation in the reference path, which is connected with

attenuator 4, results in an increase of the level at the generator output.

The +15 V supply voltage for the attenuator control is connected to the level switch S 709 via the switching stage T 724/T 725.

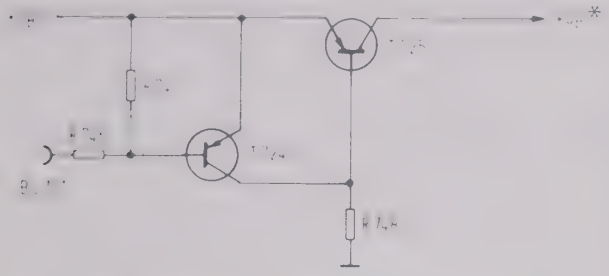


Fig. 10-3 Switching stage for supply voltage connection.

As long as R 746 is not connected to ground, T 724 is cut off via R 747 and T 725 conducts via R 748, i.e. the supply voltage $+U_B^*$ ($U_B^* = U_B - U_{CE}$). If R 746 is connected to ground, then T 724 conducts and cuts off T 725 (for remote control operation).

The switch board of level switch S 709 has 3 switching planes which are coded in such a manner that the level from plane 1 is switched in 1 dB steps, the level from plane 2 in 2 dB steps, and the level from plane 3 in 10 dB steps.

The combination of the signals for attenuator control from the level switch is carried out by means of the diodes Gl 714...Gl 717 for attenuator 1 (20 dB), Gl 722...Gl 725 for attenuator 3 (0 dB), and Gl 728... Gl 731 and Gl 749...Gl 752 for attenuator 2. Gl 749...Gl 752 are theoretcially not required but they must be installed for reasons of operational reliability of the attenuator relays Rel 709 and Rel 710 in order to keep the voltage drop across the preceeding components low. All other attenuator positions are driven directly as they are required only once in each case.

The diodes Gl 732...Gl 743 are used for decoupling the remote control mode from the manual control.

Band and Stop Filter Switching

If neither the signal "remote control" nor "stop filter buttons inoperative" is connected to the remote control socket Bu 701 and if switch S 701/III is not in the position "stop filters out", then the +15 V supply voltage is passed via the switching stage T 724/T 725 to the pushbuttons S 702/I ...S 702/III for band switching and via switching stage T 707?T 706 to the stop filter preselection buttons S 703...S 708. The 2 switching stages are basically identical and their function was already described in the Section "Level Control". The only difference is in the drive of switching stage T 707/T 706. By operating the pushbutton S 703/III "stop filters out" it is also possible to switch off the supply voltage for the stop filter switch in manual control mode. In this case the pilot lamp SL 702 "pushbuttons inoperative" is also lit.

1 band limiting filter RSB can be selected by means of each of the push-buttons S 702/I...S 702/III. The diodes Gl 701...Gl 703 decouple the manual control from the remote control and prevent a feedback of the supply voltage to T 725.

The stop filter switch is similar in function and construction to the band switch. The stop filters 1...6 are selected independently by means of pushbuttons S 703... S 708. The chokes L 701...L 706 attenuate the de-energization spikes of the relays and protect the semi-conductors.

10.1.6.2. Partial Remote Control

This operating mode is used in co-operation with the noise receiver RE-50. In this case only the stop filters are remotely controlled from the RE-50 receiver. The other functions are still switchable from the front panel.

As soon as Pin 48 (Bu 701) is connected to ground, the base of T 707 is also pulled to ground via Gl 744 and R 712. T 706 thus cuts off and the stop filter pushbuttons are made inoperative (see Section 10.1.6.1. for functional description of the switching stage T 707/T 706). The stop filters 1...6 can now be switched only via the remote control socket Bu 701 (Pins 27...30, 39 and 40). A prerequisite for this is that the "reference stop filters out" signal is not present.

If the signal "reference stop filters out" (ground) is connected via Pin 43, (Bu 701) to the base of T 727, T 728 is cut off. This disconnects the supply voltage from transistors T 708 ...& 713 and all stop filters are disconnected.

10. DESCRIPTION OF FUNCTION

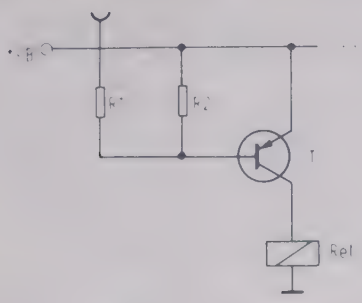


Fig. 10-4 Method of operation of the switching stage for RSS Remote Control.

If R 1 is connected to ground, the relay is connected to the supply voltage $+U_B$ via the transistor.

10.1.6.3. Complete Remote Control

If Pin 46 of the remote control socket (Bu 701) is connected to ground, then all functions - with the exception of the 10 dB level increase and the fine level control - are remotely controlled.

The signal "remote control" is passed via Gl 745 to the base of T 707 and switches off T 706 (the result of this is already described in Section 10.1.6.2), and also passed via Gl 746 to the base of T 724. This cuts off T 725 thus disconnecting the supply voltage for the RSB manual control and the level switch.

It is now possible to control RSB selection only via the switching stages T 703...T 705. These are controlled via the Pins 22...24 of the remote control socket (Bu 701). The switching stages are similar in construction and operation to those of the stop filter switches.

The level control is also carried out via the remote control socket, using Pins 1...6 and 13...16. The switching stages T 714...T 723 are again similar to those of the stop filter switches. The logical combination is carried out via the same diodes as for manual control (see Section 10.1.6.1).

When working together with the PRA-30, a signal must be returned to this unit indicating whether the level is correct. This signal is controlled by the lamp voltage "level adjusted", using the components G; 747, Gl 748, R 780, T 726, and the lamp SL 701 itself.

If the level is correct, then the lamp is lit, i.e. the supply voltage of approximately 12 V is present at Pin 34 or E. The diode Gl 747 is thus cut off as only 6 V are present at the junction of Gl 747, Gl 748, and R 779. T 726 conducts and ground potential is present at Pin 49 of the remote control socket. If the level is not correct, i.e. the lamp is extinguished, the cathode of diode Gl 747 is connected to ground via lamp SL 701. The voltage at the junction of Gl 747, Gl 748, and R 779 drops to approximately 0.8 V and transistor T 726 cuts off. Pin 49 (Bu 701) thus has practically an "open circuit".

10.1.6.4. Attenuator 2

Attenuator 2 consists of 2 separately switchable π elements with 10 dB and 20 dB attenuation. It is switched with the aid of the relays Rel 709 and Rel 710 which are driven by the level control in such a manner that the attenuation values 0, 10, 20, and 30 dB are achieved.

R 769 complements the internal resistances to 75 Ohm and C 702 and C 703 correct the frequency response.

Gl 726 and Gl 727 prevent voltage spikes when the relays are de-energized.

10.1.6.5. Attenuator 3

Attenuator 3 is designed as an asymmetrical 4 stage resistance attenuator in T shape. Its 4 attenuation stages 0, 10, 20, and 30 dB are switched independently by the reed relays Rel 705...Rel 708.

The 30 dB attenuation stage is required additionally for implementation of the "10 dB level increase" (see also Fig. 10-2) which functions as follows:

Attenuator 3 (just as attenuator 4) is connected in the reference path. A change of attenuation in this case results in a change of amplification in the adjusting amplifier which in turn results in a variation of the output level (see also 1 dB steps by attenuator 4). It is thus only necessary to increase the attenuation in attenuator 3 by 10 dB in order to achieve the required level increase. This is done with the aid of switch S 701/IV. An additional set of contacts on this switch passes on the information "10 dB level increase" to the remote control socket Bu 701, Pin 38.

In units from Series D onwards, the generator RS-50 is momentarily blanked via Gl 756...Gl 761 and R 785 in order

to prevent a level shift by approximately 20 dB in the short period, upon operation of pushbutton S 701/IV, in which the reference path is interrupted.

Capacitor C 701 improves the frequency response of the attenuator and the diodes Gl 718...Gl 721 prevent de-energization of voltage spikes.

10.1.6.6. Attenuator 4

This attenuator is constructed as a 4 stage resistance attenuator, the values being arranged according to the binary system 2^n (i.e. 1,2,4,8 dB). It switches the level in 1 dB steps. As already mentioned, it is connected in the reference path and basically effects the adjusting amplifier. The level at the input of attenuator 2 is kept constant via the control circuit. If attenuation is now inserted in the reference path with attenuator 4, without a corresponding equalization for this in the RF path, then it appears to the control circuit that the level at the measuring point drops. The control circuit thus equalizes this apparent drop, resulting in a corresponding level increase of the output.

The attenuation switching is carried out by means of the relays Rel 701... Rel 704, whose de-energization voltage spikes are limited by the diodes Gl 710...Gl 713.

10.1.7. Measuring Amplifier and Regulator (8)

The function of each of the amplifier stages is similar to that of the noise source. R 809 (NTC resistor) compensates for the temperature drift of the reference path. P 801 is used for overall level calibration. The fine level switch S 801 operates directly on the emitter resistor R 824 and thus on the amplification. C 807 carries out the necessary frequency response correction.

Due to the selection of a certain preliminary current (10f µA), the rectifier Gl 805, Gl 806 operates with a practically square characteristic at the working point. Gl 807 Gl 808 compensate for drift and thresholds at the same preliminary current. The working point between test points c and d is 100 mV. The reference voltage for this working point, which is required by IC 801, is generated by a voltage drop across R 846, via R 848 and R 844.

C 816 and C 817 prevent oscillation. Level calibration can be carried out with P 801.

Generator blanking is carried out by feeding in a positive current to the IC input. IC 801, which acts as a comparator, then switches to its (limited) negative maximum point. At the same time T 810 is switched off and the level check lamp is extinguished.

The level check is blanked when the output voltage at IC 810 exceeds +12 V , i.e. when the regulation voltage reaches is maximum value. This is, for example, the case when excessive attenuation is present in the signal path (due to RSb or RSS) or if the path is interrupted.

An excessive variation of the ring amplification, caused by the curved regulation characteristic of the adjusting amplifier, is prevented by connecting an attenuator into the regulation voltage by means of T 812 below a threshold voltage of +4 V. When this is done, the variation of steepness has a factor of only approximately 20.

10.2. BAND LIMITING FILTER RSB

The bandwidth of the noise band which is emitted by the noise source (6 kHz to 12 MHz) is reduced to the required width by means of replaceable band limiting filters.

The same sum noise power is present at the output of the noise generator for each band, which means that the narrow band must be amplified more. The overall amplification from the noise source to the final amplifier was thus selected so that the generator has its rated output power for the narrowest band (6 to 54 kHz) and wider bands have attenuation circuits. The correct output level for a 12.5 MHz wide band is attained with approximately 24 dB additional attenuation. This means that the level control circuit in the noise generator does not need to compensate for these large level variations.

A wideband receiver at the output of the generator indicates the same level as was selected at the generator, in the case of genuine effective value measurement, if its reception bandwidth is larger than that of the transmitted noise band. This is true for any band.

10. DESCRIPTION OF FUNCTION

If the reception bandwidth is smaller than that of the transmitted noise band (e.g. selective receiver) then the indication of the receiver depends on the ratio of the 2 bandwidths. The reduction in the indication with respect to the selected output level is calculated by means of the formula

$$a = 10 \lg \frac{\text{eff. bandwidth of generator}}{\text{eff. bandwidth of receiver}} \quad (\text{dB})$$

The effective bandwidth of any receiver depends on its selection curve and on the rectifier circuit used. This is repeated here for better understanding of a check measurement.

The construction of a limiting filter is divided into 3 functional units:

- Low-pass filter
- Isolating stage
- High-pass filter

The low-pass filter, which determines the upper effective limit frequency, consists of compensated parallel circuits and transverse capacitors; it is mounted on the lst 3 boards in the direction of signal flow (low-pas 1...3). Low-pass filter 4 is an additional low-pass filter whose limit frequency is always above that of low-pass filters 1...3. It is used to improve the attenuation characteristic at very high frequencies. The attenuation requirements in the stop band result from the CCITT/CCIR recommendations (25 dB with respect to pass band) and from two requirements which are a result of the generator design:

- The rectifier which evaluates the generator output level also measures the sum powers which are transmitted in the stop band and reduces the actual level in the pass range by this value.
- Distortion in the amplifiers following the limiting filters tends to "fill up" the stop band and the filter flank area with distortion power, particularly at large output levels.

For this reason, the limiting filters have a stop band attenuation, with reference to the pass band, which starts at approximately 28 dB and increases to values above 90 dB as the frequency increases.

The isolating stage can be active (for narrow limiting filters) or passsive (for wide limiting filters). The isolating stage ensures that the low-pass filters are correctly terminated. It also provides the attenuation of the pass range depending on the bandwidth (as described above) and presents the necessary internal resistance to the following high-pass filter.

The passive isolating stages consist of a resistance network (T element); the active isolating stages consist of an attenuation circuit and an amplifier stage.

The amplifier stage is constructed with 3 transistors (see Fig. 10-5). The first stage operates as a common collector stage which drives the emitter of the 2nd transistor. Voltage amplification is carried out with T 2. The amplified signal at the collector resistor of T 2 can be extracted via a further common collector stage T 3.

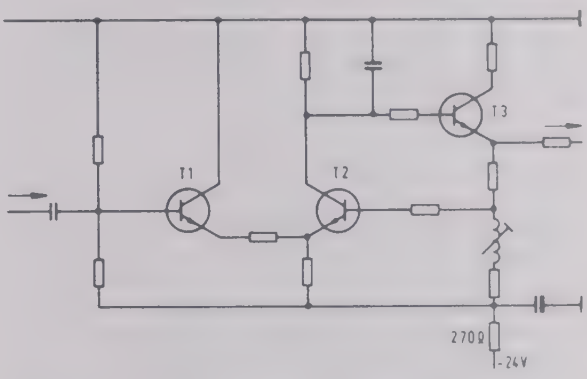


Fig. 10-5 Active isolation stage of a band limiting filter

Part of the output voltage is connected back to the base of T2 as a negative feedback. The amplification of the isolation stage is reduced to V = 1 with this negative feedback. The -24 V supply voltage is fed into the filter via the wiper contacts on the bottom side.

The isolation stage is followd by a 2 element high-pass filter consisting of the boards high-pass 1 and high-pass 2.

The lst high-pass capacitor is mounted on the isolation stage board.

Similar considerations exist for the stop band of the high-pass filter as for the low-pass filter, i.e. that the distortion power reduces the effective stop attenuation due to non-linearity of the amplifiers. The requirements for stop band attenuation are not so great in this case as the ratio between pass band and stop band is not so extreme in any filter type.

10.3. BAND STOP FILTERS RSS

Just like the band limiting filters, the band stop filters are designed as plug-in units for the noise generator RS-50 and up to 6 of these filters can be installed in the RS-50.

The band stop filters for frequencies up to 5 MHz are designed as LC filters. They consist basically of series and parallel circuits which are tuned to the blocking frequency of the appropriate filter. Above 500 MHz, crystal filters are used for measurements within the band. At frequencies between 230 kHz and 11700 kHz , 5th degree filters are used. Below 230 kHz, band stop filters of a higher degree with poles distributed across the stop range are used. Special circuits are fitted in the outside band stop filters RSS 119, RSS 600, and RSS 9073 in order to keep the attenuation low even at the edges of the pass range. The termination resistance for all stop filters is 75 Ohm.

10.4. NOISE RECEIVER RE-50

10.4.1. RF Pre-attenuator, Pre-attenuator Control, and Distributor (2)

The RF pre-attenuator consists functionally of 2 parts: The first part with an attenuation range of 0 to 30 dB is switched from the reference level switch S 602 in steps of 2 dB by means of a diode matrix.

The 2nd part, with the adjustable attenuation values 0.10,20 dB, is controlled by the measuring range switch S 603.

All relay switching stages are constructed identically. If L potential is connected to all inputs of the 6 switching stages (points 64, 63,62,46, 44,42), then the relays Rel 201 to Rel 206 are energized. The first part of the RF pre-attenuator thus has an attenuation of 0 dB and the 2nd has an attenuation of 30 dB. Each potential at the input of one switching stage in the first part of the pre-attenuator causes attenuation; in the 2nd part is causes no attenuation.

Table 7-4 shows which attenuation elements are connected, depending on the switch positions of S 602 and S 603.

The distributor has the following tasks:

- The converter plug-ins REU constantly receive a -20 V supply via Pin a3 of the multiple plugs St 202, St 206 to St 222 so that the continuity loop is connected through these plug-ins via a relay contact.

- Pin C 3 transmits the -20 V coming from the frequency switching assembly (3) which energizes the appropriate converter plug-in. When this voltage is applied to the REU, the continuity loop to the next plug-in is interrupted.
  From series D onwards: for automatic frequency switching, the -20 V supply is passed via c6-a6 to the control unit RKS-50 when the slide switch on the appropriate converter plug-in is in the on position and causes the REU to remain switched on for the selected time period.

- The RF signal is passed via the coaxial plugs St 203, St 205, St 207 to St 223 to the converters.

- The AF signal at the converter outputs is connected to a bus which leads to the AF filter (4) via the coaxial plugs St 204, St 208 to St 224.

10.4.2. Frequency Switching (3)

With the aid of the frequency switching assembly, the converters can be selected manually by means of switch S 301 which connects a -20 V supply to the converter plug-ins via switching transistors T 306, T 310, T 314 to T 326 (outputs 12,10...2).

In parallel to the switching transistors, an L signal is supplied to the contacts 40,39...27 of the output socket Bu 301 so that the band stop filters in the noise generator RS-50 corresponding to the selected converters can be connected.

In addition to this the converter plug-ins can be selected externally by means of a binary code 1-2-4 (TTL level) via contacts 31, 32, and 33 of socket Bu 301. Switch S 301 is then inoperative.

The truth table for the interesting range of the BCD-Decimal decoder IC 303 is shown in negative logic in Table 10-2.

The D input is permanently connected to L potential. If no external control is carried out via inputs C, B, and A, these are connected via resistors R 326, R 329 and R 331 to

H potential. As can be seen from the truth table, the output 7 of the decoder IC 303 then has L potential. This means that transistor T 302 is cut off, T 301 conducts, and the wiper of switch S 301 is connected to ground potential (L).

Input				Output						
D	C	B	A	1	2	3	4	5	6	7
L	H	H	H	H	H	H	H	H	H	L
L	H	H	L	H	H	H	H	H	L	H
L	H	L	H	H	H	H	H	L	H	H
L	H	L	L	H	H	H	L	H	H	H
L	L	H	H	H	H	L	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H

Table 10-2 Truth table of the BCD-Decimal decoder

If switch S 301 is now switched to position 6, for example, then the input of inverter IC 301/6.2 has L potential, and its output has H potential. The H potential causes transistors T 303, T 305, and T 306 to conduct. Converter 6 receives -20 V via T 306 and is connected in the circuit.

In addition, Pin 40 of the remote control socket Bu 301 has L potential which switches in stop filter 6 in the RS-50 generator if a control connection to this unit exists.

The operations described above are repeated in a similar manner for the other switch settings of S 301.

The diodes Gl 301, Gl 302, and Gl 303 and the corresponding diodes of the other 5 switching stages are used to ensure that the following switching transistors are correctly cut off.

Diode Gl 305 prevents a breakdown of the base/emitter diode of T 305 in the reverse direction when the switching stage is switched off. Diode Gl 304 prevents the stage from being switched on with the RS-50 generator connected but switched off.
The same is true for the other switching stages.

In the case of external control with BCD code, the wiper of the frequency switch S 301 is connected to H potential so that this switch is inactive. The switching stages are now driven by the outputs of the decoder IC 303.

Example:
The potentials LLH are connected to the inputs CBA (see also truth table).

In this case output 1 has L potential and all other outputs of the decoder have H potential. This causes transistors T 304, T 303, T 305, and T 306 to conduct - as already described - and converter 6 and stop filter 6 are connected into the circuit.

The 5 V supply voltage for the TTL circuits used is obtained from the +12 V supply voltage with the voltage divider R 355/R 357 and transistor T 327 (in order to obtain a low internal impedance). Resistor R 356 prevents destruction of transistor T 327 if the +5 V line should have a short circuit to ground.
Capacitor C 301 is used to filter out ripple voltage.

10.4.3. AF Filter (4)

The AF filter module has an overall amplification of V = 34 dB in the pass range (f = 600 Hz). The lower limit frequency of the filter is at f_u = 300 Hz, the upper limit frequency is f_o = 1 kHz. The effective noise band width is Δf = 692 Hz $\pm$1%.

The resistor R 401 at the input of the module forms the termination resistor for the converter REU. The filter element, consisting of the Series Circuit R 402/R_i of the converter and of C 401, attenuates the remaining carrier from the converter and thus prevents overdriving of the following amplifier stage with IC 401/2.1.

The input amplifier, with the relatively high amplification of V = 24 dB, ensures that the intrinsic noise of the following active filter stages can be neglected. The intrinsic interference indication of the basic unit RE-50 is thus mainly determined by this 1st amplifier stage.

These circuits are followed by a low-pass filter of the 9th degree, consisting of 4 stages with the amplifiers IC 401/2.2, IC 402/2.1 , IC 402/2.2, and IC 403/2.1, and a high-pass filter of the 3rd degree with amplifier stage IC 403/2.2. All 5 amplifier stages have an amplification of V = 0 dB. The attenuation values of the AF filters are dimensioned so that

- The 50 Hz and 100 Hz ripple voltage on the signal path is sufficiently suppressed,
- the sum attenuation of the series circuit AF filter and band stop filter is greater than 85 dB.

10. DESCRIPTION OF FUNCTION

The filter module is terminated by a 10 dB amplifier stage with IC 404. The frequency response towards the higher frequencies is reduced by capacitor C 423 in the negative feedback path and the limit frequency is approximately 5 kHz.

The -12 V supply voltage is obtained from -20 V by voltage division, transistor T 401 providing a low internal resistance of the source.

In units from series C onwards, the construction of the module is partially changed: the input amplifier consists in this case of a differential amplifier T 401 and T 402, constructed with discrete components, which already supplies the overall amplification of 34 dB for the module. This is followed by an operational amplifier IC 401 whose output signal is fed back to the 2nd input of the differential amplifier with a negative feedback factor of 34 dB. IC 401 thus operates with a loop amplification of 0 dB for which there is an upper limit frequency of 1 MHz.In the negative feedback path, the upper limit frequency is determined by R 409 and C 406 and is approximately 14.5 kHz. The lower limit frequency is approximately 50 Hz due to R 407 and C 404.

The differential amplifier with T 401 and T 402 which preceeds the operational amplifier IC 401 is set to a limit frequency of approximately 12 kHz by C 403. A tendency of the amplifier arrangement to oscillate is thus avoided.

The differential amplifier has a very low noise factor. The noise of the following stages is reduced by 34 dB with respect to the input.

This input amplifier stage is followed by the active low-pass and high-pass filters which are identical to previous models.

10.4.4. Measuring Mode/System Attenuator (5)

With the aid of the switch measuring mode/system S 501, the differences in the reference level for S/N and NPR measurements are equalized in such a manner that the pointer of the meter points to the alignment mark ▼ in the reference measurement.

The attenuation values of the attenuator depend not only on the setting of switch S 501 but also on that of the measuring range switch S 603 (see also Section 10.4.5).

If the measuring range switch S 603 is not in the position ▼ , the input of the switching stage with transistors T 501 and T 502 is high and relay Rel 501 is de-energized. Contact Rel 501a connects point 6 with the resistor R 520 and contact Rel 501b has no function. Depending on the setting of switch S 501, only 2 attenuation values are then possible, namely in position 1 (NPR) through divider R 505/R 519 and in positions 2...14 (S/N) through divider R 505/R 520.

In the positions 2...14 (S/N) the attenuation value is 19.1 dB. This is the result for Y_C in the largest possible system which can be handled by the RE-50 receiver, a system with 2700 speech channels.

The definition for Y_C is:

$$Y_C = 10 \lg \frac{\Delta f_s}{\Delta f_E} - p^*_{\Sigma,C}$$

Δf_s = noise bandwidth of the generator

Δf_E = reception bandwidth (1.74 kHz)

$p^*_{\Sigma,C}$ = conventional load

$p^*_{\Sigma,C}$ depends on the number of channels in the system and is calculated as follows:

$$p^*_{\Sigma,C} = \begin{cases} 4 \lg n - 1 \text{ dBm0} & \text{for } < 240 \text{ channels} \\ 10 \lg n - 15 \text{ dBm0} & \text{for } \geqq 240 \text{ channels (CCI)} \\ 10 \lg n - 15 \text{ dBm0} & \text{for } \geqq 240 \text{ channels (Bell)} \end{cases}$$

In units of seris A...D, the calculation of the Y_C value is based on the CCI formula for $p^*_{\Sigma,C}$. From series E onwards, the Bell formula is used so that the value for Y_C is changed from 19.1 to 20.1 dB.

In position 1 (NPR) of switch S 501, the attenuation value is 10 dB lower, namely 9.1 dB (series A...D) or 10.1 dB (from series E onwards).

During reference measurement (position ▼ of the measuring range switch) the input of the switching stage of transistors T 501 and T 502 is connected to ground which means that relay Rel 501 is energized. Contact Rel 501 connects point 6 to the wiper of the 2nd switch plane S 501 II, and contact Rel 501b connects the contact 43 of socket Bu 301 to ground so that all stop filters of a connected noise generator RS-50 are bridged by means of the remote control.

In position 1 (NPR) of switch S 501 there is again an attenuation of 9.1 dB namely due to division in the

10. DESCRIPTION OF FUNCTION

Position of switch S 501		Attenuation connected			
Measuring mode	System channels	Series A...D		Series E onwards	
		Measuring	"Reference" (S 603 to ▼)	Measuring	"Reference" (S 603 of ▼)
NPR	-	9.1 dB	9.1 dB	10.1 dB	10.1 dB
S/N	12	19.1 dB	7.75 dB	20.1 dB	8.73 dB
	24		6.05 dB		7.03 dB
	36		5.2 dB		6.2 dB
	60		3.8 dB		4.8 dB
	72		3.3 dB		4.3 dB
	96		2.4 dB		3.4 dB
	120		1.7 dB		2.7 dB
	132		1.7 dB		2.7 dB
	192		0.6 dB		1.6 dB
	≧ 240 (CCI)		0.2 dB		1.2 dB
	≧ 240 (Bell) [1]	-	-		0.2 dB

1) This switch position is available only in the special version BN 643/1

Table 10-3 Attenuation values of the measuring mode/system attenuator

esistors R 505 and R 519. In the positions 2...14 (S/N) different attenuation values are selected, depending on the system which is being measured, and result from division in the resistors R 505 and R506...R 515 or R 516 (from series E onwards. The necessary attenuation value for the selected system (number of channels) is determined from the formula

$$a/dB = 19.1 - Y_C \quad \text{(Series A...D)}$$
$$20.1 - Y_C \quad \text{(from Series E onwards)}$$

Table 10-3 shows the attenuation values depending on the measuring mode and the system.

In front of the attenuator, the AF output I, Bu 501, is connected via resistor R 504. A noise monitoring receiver can be connected here, the internal resistance with 4.64 kOhm being used for level matching.

10.4.5. AF Amplifier (6)

The following functions are implemented in the AF amplifier:

- With S 601 adjustment of the relative level in 0.2 dB steps from +0.2 to -4.2 dBr
- With S 602 adjustment of the relative level in 2 dB steps from -38 to -56 dBr
- With S 603 alignment and sensitivity adjustment from -10...-70 dBm0p or $10^8...10^2$ pWOp.

The amplification of stage IC 601 can be adjusted in 0.2 dB steps from V = +4.9 dB...+9.3 dB by varying the negative feedback path with the aid of switch S 601. The signal is fed into the non-inverting input of this amplifier whose input resistance is formed by R 610.

Stage IC 602 operates as an inverting amplifier whose amplification in the negative feedback path is adjustable in steps of 2 dB from V = -8 dB... V = +10 dB with the aid of S 602.

Stage IC 603 is used as a non-inverting amplifier with a constant amplification of V = 20 dB. The negative feedback is frequency dependent, and the upper limit frequency of the frequency response is approximately 13 kHz. The output of this amplifier stage is connected to the AF output II, Bu 603 via R 650. The digital level meter PMD-1 can be connected here for automatic noise measurements.

Stage IC 604 supplies an amplification of 0 dB or 10 dB, depending on the operational state of Rel 601. The stages IC 605 and IC 606 each have a constant amplification of 20 dB. The upper limit frequency of the frequency response is set to approximately 13 kHz again with C 612 and C 614. An attenuator of 20 dB is fitted at the input of each of these 2 amplifiers. These attenuators are controlled by relays Rel 602 and Rel 603.

All relay switching stages are operated by the measuring range switch S 603 in manual mode, the wiper of this switch being connected via T 604 to ground. In positions 1...3, the inputs of the switching stages are high and the relays are not energized, i.e. relay contacts Rel 601, Rel 602, and Rel 603 are open. The overall amplification of the stages IC 604 to IC 606 is then 0 dB. Table 10-4 shows which amplification in the last 3 stages of the AF amplifier is effective in positions 4...8 of the switch S 603.

Switch position S 603	Amplification Stage IC 604 dB	Stage IC 605 dB	Stage IC 606 dB	Total dB
4	10	0	0	10
5	0	20	0	20
6	10	0	20	30
7	0	20	20	40
8	10	20	20	50

Table 10-4 Amplification of the last 3 stages of the AF Amplifier

In position 1 of switch S 603, points 7 and 8 of board 643-K.. receive ground potential via T 604 so that the 20 dB attenuator in the RF preattenuator (2) is connected and the measuring mode/system attenuator (5) is set to reference ▼ .

In position 2, point 9 received ground potential which results in connection of the 10 dB attenuator in the RF preattenuator (2).

If point 6 is connected to ground via Pin 35 of the remote control socket Bu 301, T 604 and T 603 cut off. This results in deactivation of the measuring range switch S 603 and selection of the settings for reference measurement ▼ in the RF preattenuator and in the measuring mode/system attenuator via the transistor T 602 which now conducts.

In units from series D onwards the circuit has been extended slightly. If point 16 is connected to ground via pin 36 of the remote control socket Bu 301, only transistor T 604 is cut off (but not T 603!) so that switch S 603 is inactive. As, in this case, the receiver is not switched to reference measurement ▼ the external control of relays Rel 601, Rel 602, Rel 603, and Rel 205 for selection of the measuring range is possible.

The -12 V supply voltage is obtained from -20 V by voltage division, T 601 providing a low internal resistance.

The headset socket Bu 604 is connected to the output of the AF amplifier.

10.4.6. Rectifier, Quasi Effective Value Circuit, Logarithmer, and Indication (8)

This module is designed so that an input level of +10 dBm ≙ 870 mV results in an indication α = +10 on the meter J 801. Evaluation of white noise and sine-wave signals is equal which means that testing and adjustment of this module can be carried out with a sine-wave signal.

The low frequency noise signal is passed via a limiter to a average value rectifier with amplifiers IC 801 and IC 804 and transistors T 801... T 804. The limiter, consisting of the resistor R 855 and the 2 zener diodes Gl 810 and Gl 811, prevents over-driving of the rectifier. The signal, which is amplified with V_o, is limited at the base of transistors T 801, T 802 and T 803, T 804 to approximately ±600 mV. The emitters of transistors T 803, T 804 are always at 0 potential, the emitters of T 801, T 802 follow the input signal with the same amplitude.

In the case of a positive input signal, the transistors T 801 and T 804 conduct, and T 802 and T 803 conduct for a negative input signal. As the resistors R 806 and R 808 have the same value, the half wave amplitude at the input of the amplifier IC 803 has the same size as the input signal of the rectifier.

The amplifier stage IC 802 is used for division of the supply voltage. Its output voltage is fixed at -10 V and forms the symmetrical input potential for the 2 following stages, the

10. DESCRIPTION OF FUNCTION

quasi effective value circuit with IC 803 and the current source with IC 805.

The quasi effective value circuit is a switching stage which operates with a defined internal resistance R 811 on a similarly defined load resistance R 812. With a ratio $R_i = R_a = 1{:}3.8$, the average value rectifier evaluates sine-wave signals and white noise equally. Capacitor C 805 provides a charging time constant of approximately 0.27 s and discharging time constant of approximately 1 s.

When the signal at the input of the quasi-effective value circuit drops below the DC voltage on capacitor C 805, transistor T 805 cuts off. Resistor R 809 with diode Gl 801 prevents the negative feedback path of amplifier IC 805 from being interrupted when T 805 cuts off and thus prevents the output of the amplifier from being driven almost to the negative supply voltage. The DC voltage on capacitor C 805 is converted in the following current source with IC 805 and T 806 into a current proportional to the voltage, this current feeding the logarithmer. This current can be adjusted with trimmer P 802, thus adjusting the overall amplification of the indication board.

(Diode Gl 802 is used for connection of a measuring resistor in the test adapter for this module used in the factory in order to adjust the basic current for indication 0 ($\alpha = -20$ on the meter).

The logarithmer consists basically of the amplifier IC 806, the transistors T 811, T 812, T 814, which are connected as diodes, and the compensation diodes T 808, T 809, and T 810.

A constant preliminary current flows through the last 3 diodes mentioned above, being determined mainly by the supply voltage -20 V and the resistor R 816. An approximately equal current, which is temperature dependent, and which is obtained from the circuit with the transistors T 807, T 813, and T 815, is added to this preliminary current. This circuit is a differential amplifier, 1 input of which receives constant voltage via the voltage divider R 822, P 805, and R 823, the other input receiving a temperature dependent voltage from diodes Gl 803...Gl 805. The voltage at the base of T 807 can thus rise or fall, depending on the temperature and the position of potentiometer P 806, thus causing a rise or drop in the current through T 807. Alignment is carried out with P 805 at room temperature so that the voltage across P 806 is approximately 0.
The output voltage of the meter amplifier is then adjusted to 0 with P 803, by equalizing the varying threshold voltages of diodes T 811, T 812, and T 814, together with T 808... T 810, and the 0 voltages of the amplifiers IC 806, IC 807, and IC 808.

As the output voltage of the logarithmer (output of IC 806) increases in a linear manner with increasing temperature, it must be followed by an amplifier with an opposed temperature coefficient for equalization purposes. This requirement is fulfilled with amplifier IC 807 which has a PTC resistor in a resistor bridge circuit in the negative feedback path. At room temperature, the bridge is adjusted with P 809 so that the voltage across P 808 is 0. As the ambient temperature rises, the resistor bridge becomes unbalanced as a larger voltage is dropped across the PTC resistor R 835 than at room temperature. The negative feedback factor for the amplifier is thus changed in such a manner that the amplification is reduced as the temperature increases. The amplitude of this temperature dependent amplification variation can be adjusted with P 808.

The overall amplification of IC 806, IC 807, and IC 808 is adjusted with potentiometer P 807.

The meter amplifier with IC 808 is designed so that a voltage of approximately +5 V is present at its output for full scale deflection of the meter. Optimum temperature compensation for the meter is then provided by the series resistors R 839 and R 840. Diode Gl 807 protects the instrument from overloading if the amplifier has a negative output voltage.

The full output voltage of the amplifier is availavle via an internal resistance of approximately 5 kOhm at the output point 20 of the board. This can be fed to output socket Bu 801 if required. In units from series D onwards, the output voltage of the meter amplifier is fed to pin 12 of the remote control socket Bu 301.

A recorder voltage can be extracted via pin A of Bu 801 and can be adjusted with potentiometer P 810 on the front panel between 0 and 200 mV. The source resistance is approximately 2.4 kOhm.

Diodes Gl 808 and Gl 809 limit negative output voltages of amplifier IC 808.

The -12 V supply voltage is obtained by voltage division from -20 V, transistor T 816 providing a low internal impedance.

In units from series D onwards, the meter circuit has been modified. The recorder output Bu 801 is now coupled to the output of the logarithmer via a separate recorder amplifier IC 809 and T 817. The charging time constant of 5 ms is determined by R 859 and C 810 and the discharging time constant of 600 ms by R 858, R 860, R 861, and C 810.

Diode Gl 813 protects C 810 from excessive negative voltages. The voltage at the recorder output is adjusted with potentiometer P 811.

The time constant for the meter and for the measured value output available at pin 12 of the remote control socket Bu 301 is determined by R 836 and C 811.

10.5. CONVERTER PLUG-INS REU

The converter plug-ins REU filter the measured signal out of a noise band with varying widths and pass it on, after conversion to 0 Hz, to the AF filter of the RE-50 receiver. After the RF preattenuator of the receiver has attenuated the incoming noise signal as required, a preselection is carried out in the prefilter and the signal is transformed up by 10 dB. This is followed by amplifier stage 1. normally with an amplification of 0 dB, which forms the termination resistor of the prefilter and feeds the following band-pass filter with low impedance. The pass band of this filter is at least 1 kHz but it normally more. In some cases it has a voltage amplification by

Frequency kHz	Amplifier I	Band pass	Amplifier II	Oscillator
10	A	A	A	A
16	B	B	A	A
50	B	B	A	A
57	B	B	A	A
70	B	B	A	A
98	B	C	A	A
119	B	C	A	A
140	B	C	A	A
230	B	C	A	A
240	B	C	A	A
270	B	C	A	A
331	B	C	A	A
394	B	C	A	A
534	B	C	A	A
600	B	C	A	A
770	B	C	A	A
1002	B	C	A	A
1248	B	C	B	B
1549	B	C	B	B
1730	B	C	B	B
2438	B	C	B	C
3150	C	D	B	C
3200	C	D	B	C
3886	C	D	B	C
4650	C	D	B	C
4715	C	D	B	C
5340	C	D	B	C
6300	C	D	B	C
7600	C	D	B	C
9073	C	D	B	C
11700	C	D	B	C
13677	D	D	B	C

Table 10-5

transformation between 10 and 20 dB. The amplifier stage II serves as a termination resistor for the band-pass filter and has an amplification between 6 and 10 dB, and feeds the converter via an adjustable attenuator with which the overall amplification is adjusted. The carrier for the converter, a square-wave voltage with the rated frequency of the REU, is generated in

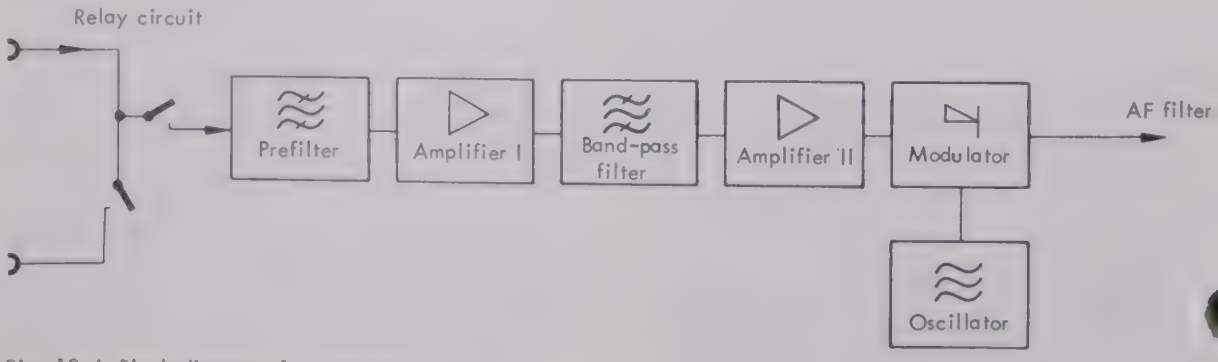


Fig. 10-6 Block diagram of a converter plug-in

the oscillator. 2 sidebands are thus generated at the output of the converter and are added together, starting at f = 0 Hz and passed to the input of the AF filter of the RE-50 receiver.

Depending on the rated frequency of the REU, the various assemblies - except for the prefilter, modulator, and relay circuit, differ in their construction. The table 10-5 shows which construction is used for which frequencies. This is followed by a description of the circuits.

10.5.1. Prefilter

The prefilter consists of a longitudinal series circuit and a transverse parallel circuit which are tuned to the nominal frequency of REU. Parallel resistors in both circuits adjust the circuit magnification factor to approximately 20.

The input resistance is 75 Ohm the output resistance is 2.4 kOhm.

The signal voltage is transformed up by approximately 10 dB in the transformer of the parallel circuit, due to the winding ratio. In some cases a capacitance or an RLC series circuit is connected in parallel to the series circuit in order to improve the reflection factor.

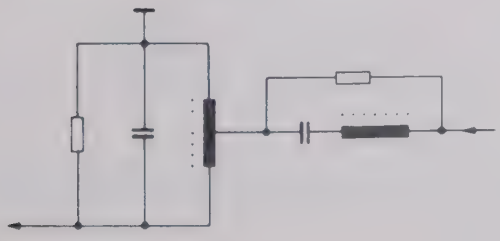


Fig. 10-7 Circuit of the prefilter

Preselection by the forfilter is necessary in order to avoid loading amplifier I by the whole band and thus to reduce its intrinsic intermodulation noise.

10.5.2. Amplifier I

The signal coming from the prefilter is amplified in T 1a and T 1b which operate as a differential amplifier. It is passed from the collector of T 1a to T 2 and amplified again at this point. T 3 acts as an emitter follower and feeds 1/10 of the amplified noise voltage back to the base of T 1b via the voltage divider R1 - R2. This determines the amplification factor of 10 corresponding to 20 dB.

Version A:

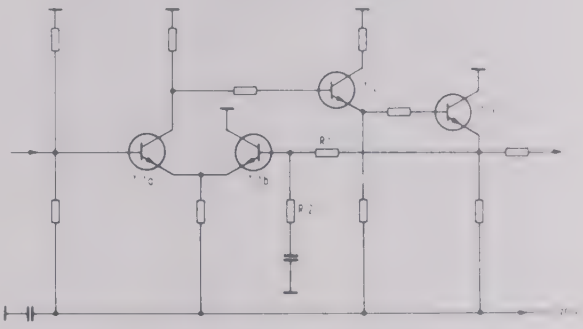


Fig. 10-8 Circuit of amplifier I (Version A)

Version B:

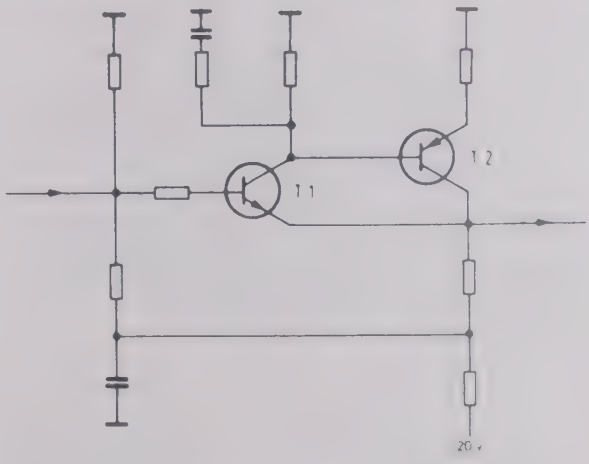


Fig. 10-9 Circuit of amplifier I (Version B)

The signal coming from the prefilter is amplified in T 1 passed to the base of T 2, and amplified again. It is passed completely to the emitter of T 1 as a negative feedback from the collector of T 2. This results in an amplification factor of 1 corresponding to 0 dB and a very low input resistance in the order of 1 Ohm. The RC circuit on the collector of T 1 is used for stabilization of the negative feedback amplifier.

Version C:

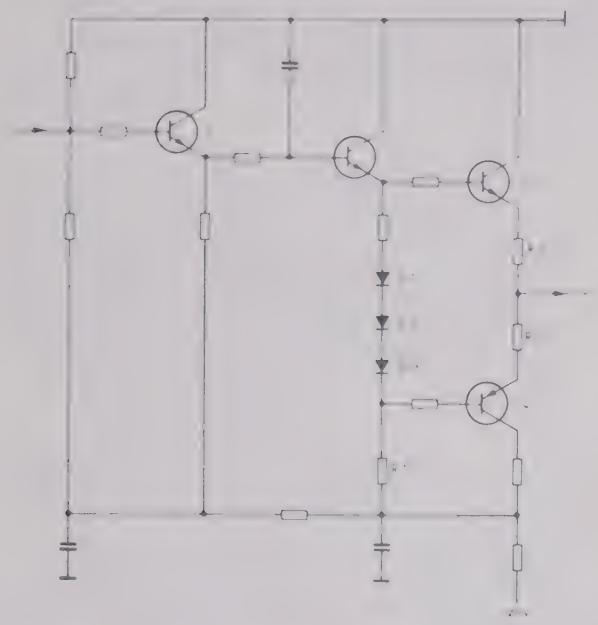


Fig. 10-10 Circuit of amplifier I (Version C)

The signal coming from the prefilter is connected to the chained emitter stages T 1 and T 2. The signal generated at the emitter resistor R 1 controls the push-pull emitter stages T 3 - T 4. Diodes G1 1...G1 3 determine the DC working point of transistors T 3 and T4. R 2, R 3, and the internal resistances of transistors T 3, T 4 form a part of the preliminary resistor for thr band-pass filter. The amplifier has an amplification factor of approximately 1 (approximately 0 dB).

Version D:

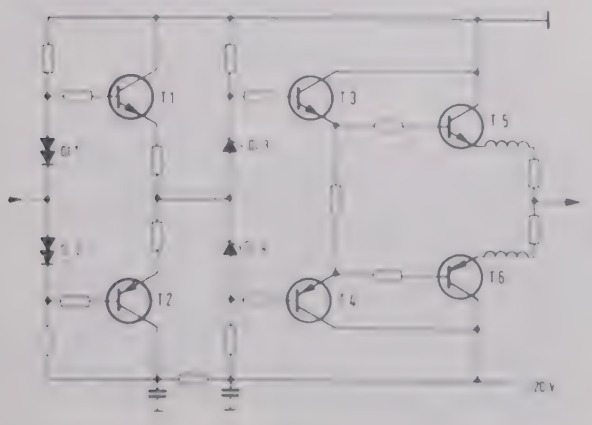


Fig. 10-11 Circuit of amplifier I (Version D)

The whole circuit is designed as a chain of 3 sequential push-pull emitter stages. The diodes G1 1...G1 4 are used for adjusting the working point of these push-pull stages. The amplification factor is approximately 1 (approximately 0 dB).

10.5.3. Band-Pass Filter

Version A:

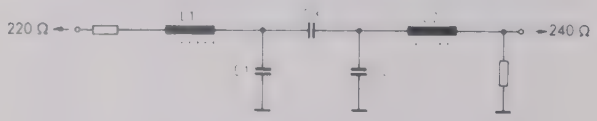


Fig. 10-12 Circuit of band-pass filter (Version A)

The band-pass filter consists of the 2 tuned circuits L1/C 1 and L 2/C 2 which are coupled supercritically via C 3.

Due to this, and due to the selection of its termination resistors, there is a ripple of approximately 1.6 dB. Together with the selection curve of the prefilter, a relatively flat wide pass curve is obtained.

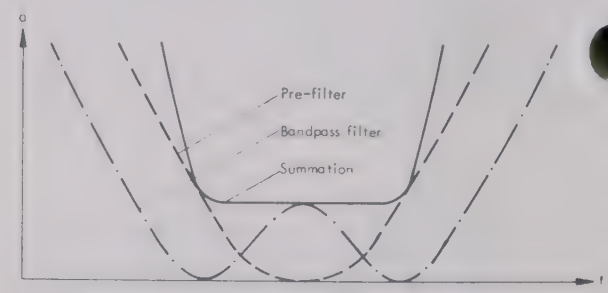


Fig. 10-13 Pass curve of prefilter and band-pass filter

Version B:

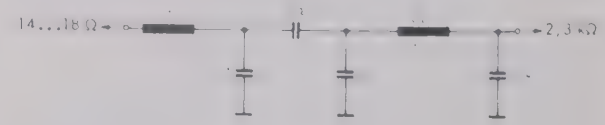


Fig. 10-14 Circuit of band-pass filter (Version B)

The band-pass filter consists of the 2 tune circuits L 1/C 1 and L 2/C 4 which are coupled supercritically via C 3 . Due to this and due to the selection of its termination resistors, a ripple between 1 and 2 dB is obtained. Together with the selection curve of the prefilter a relatively flat wide pass curve is obtained (see Fig. 10-13).

C 4 results in voltage transformation (amplification).

Version C:

Fig. 10-15 Circuit of band-pass filter (Version C)

The function of the band-pass filter and the numerical values are the same as for Version B but the coupling of the 2 circuits is not in the form of a π element but as a T element.

Version D:

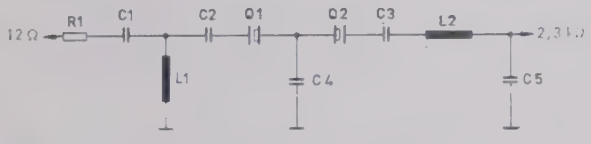


Fig. 10-16 Circuit of band-pass filter (Version D)

The actual band-pass filter operates as described for Version C except that the series circuits are replaced by a crystal with a series alignment capacitor C 2 (C3).

The circuit C 1/L 1 and L2/C 5 are each a resonant transformation stage with different amplifications in each REU.

In REU-3200, the transformation stage L2/C 5 is missing. The resistor R 1 complements the source resistance of the amplifier I to 59 Ohm.

Amplifier stage II forms the termination resistor. The crystal band-pass filters are, in contrast to all other bans-pass filters, exclusively responsible for the selection.

10.5.4. Amplifier II

Version A:

The input signal is amplfied in T 1, passed to T 2, and amplified again. Half of the amplified signal is fed back as negative feedback to the emitter of T 1 via voltage divider R 1, and R 211 in parallel with R 3. The amplification factor of the stage is thus 2. corresponding to 6 dB. The signal thus amplified is passed via an adjustable voltage divider with which the overal amplification of the REU is adjusted to the modulator.

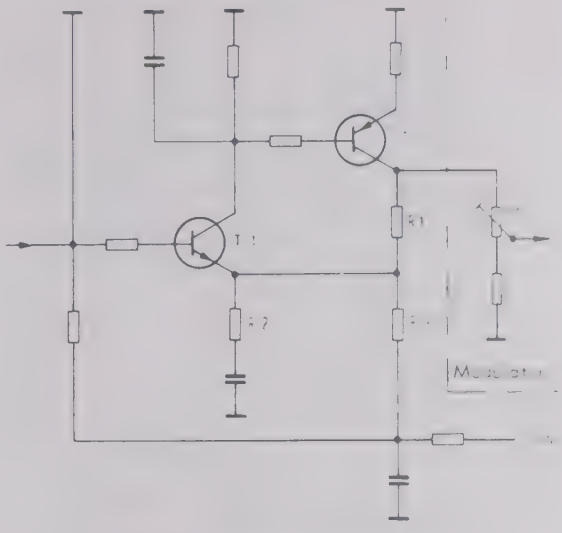


Fig. 10-17 Circuit of amplifier II (Version A)

Version B:

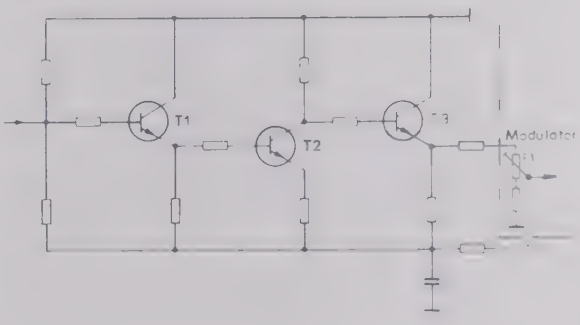


Fig. 10-18 Circuit of amplifier II (Version B)

The input signal is applied to the common emitter stage T 1. This drives transistor T 2 which amplifies by approximately 10 dB. A common emitter stage T 3 feeds the modulator via an adjustable voltage divider for align-ment of the overall amplification.

10.5.5. Modulator

The modulator is a normal ring modulator in which the carrier current is impressed via the differential amplifier T 1- T2. The tuned circuit U2/C 1 is tuned to the nominal frequency of the REU and effects the selection curve slightly, particularly at low frequencies, depending on the setting of P 1.

10. DESCRIPTION OF FUNCTION

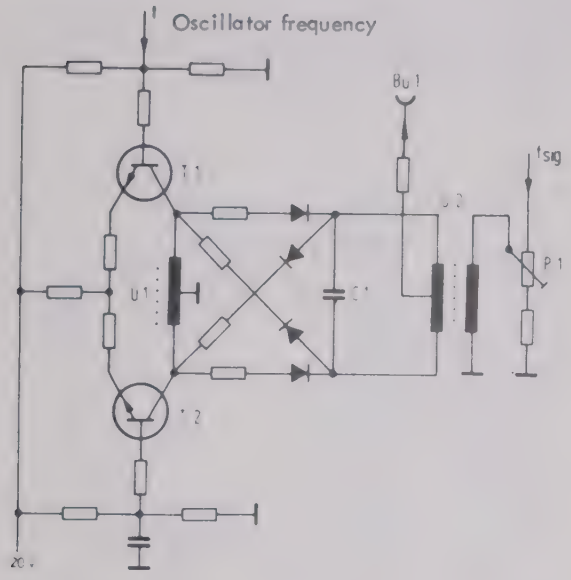


Fig. 10-19 Circuit of the modulator

The converted signal is generated at Bu 1, the output of the mixer, across the load R_a = 100 kOhm in parallel with 3.3 nF (this corresponds to the input resistance of the RE-50).

If a noise band is applied to the input of the converter plug-in then 2 overlapping noise sidebands are available at socket Bu 1, starting at 0 Hz. Their characteristic is determined by the overall selection of the converter plug-in.

10.5.6. Oscillator

Version A:

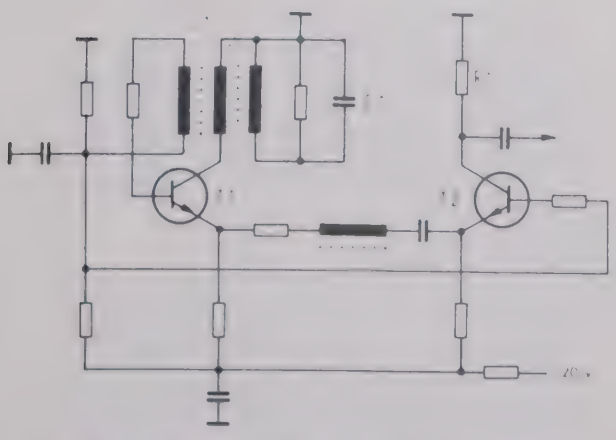


Fig. 10-20 Circuit of the oscillator (Version A)

The oscillator with transistors T 1 and T 2 generates a square-wave voltage for conversion. The frequency is equal to the nominal frequency of the REU.

The sine-wave generated at U 1 drives the transistors T 1 and T 2 , which operate as a differential amplifier, into limiting. A square-wave voltage is then available at R 1 and is fed to the modulator.

Version B:

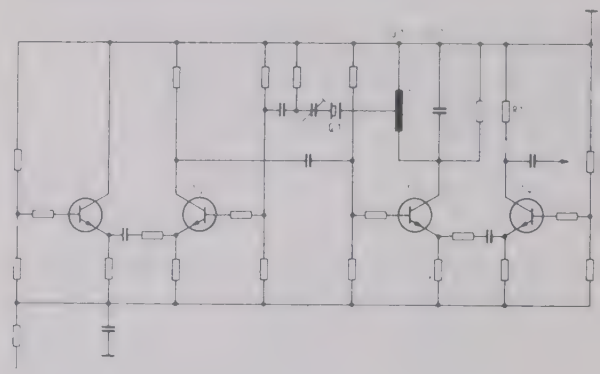


Fig. 10-21 Circuit of the oscillator (Version B)

The frequency of this oscillator is determined by the crystal Q 1. This operates in series resonance in the feedback path.

Transistors T 1 and T 2 form a differential amplifier. The amplified fed back voltage is passed to the base of T 3. This drives the transistors T 3 and T 4, which operate as differential amplifier and limiter, and generates a square-wave voltage at R 1 which is passed to the modulator.

Version C:

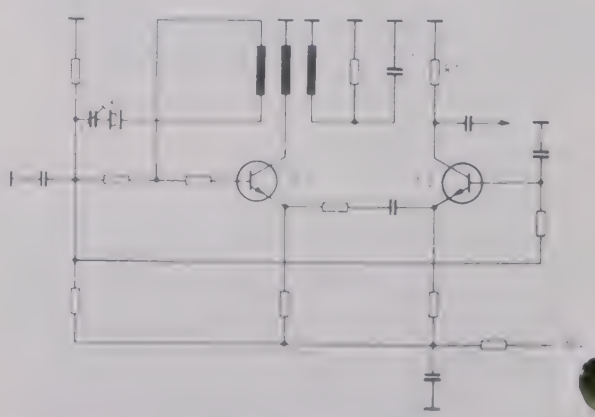


Fig. 10-22 Circuit of the oscillator (Version C)

10. DESCRIPTION OF FUNCTION

Basically, this circuit operates like version B except that the feedback voltage is not amplified by a further stage.

10.5.7. Function of the Converter Plug-ins in the RE-50 Receiver

Control and sequential switching of the various converter plug-ins is carried out as shown in Fig. 10-23.

The rightmost REU in Fig.10-23 receives its input signal from the RF pre-attenuator. If this plug-in is selected with the REU preselection switch S 301 of the receiver, then the input relay (Rel 1) connects the converter plug-in to the input signal and relay Rel 2 for sequential switching is de-energized.

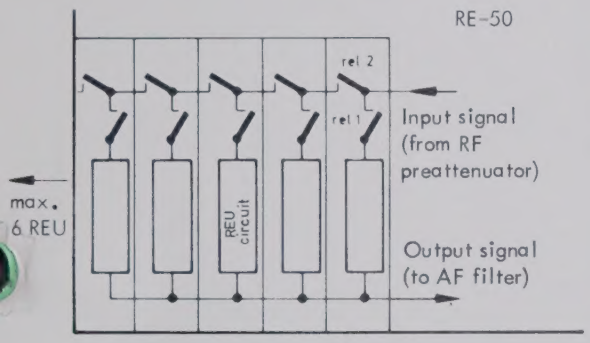


Fig. 10-23 Converter plug-ins in the receiver

If the REU is not selected by the receiver, Rel 2 passes the input signal onto the next REU and Rel 1 is de-energized.

If any REU in the chain is selected then the input signal is looped through all preceeding plug-ins, but the following REUs are switched off at the input side. The output of all REUs is connected directly in parallel in the receiver.

10.5.7.1. Relay Circuit

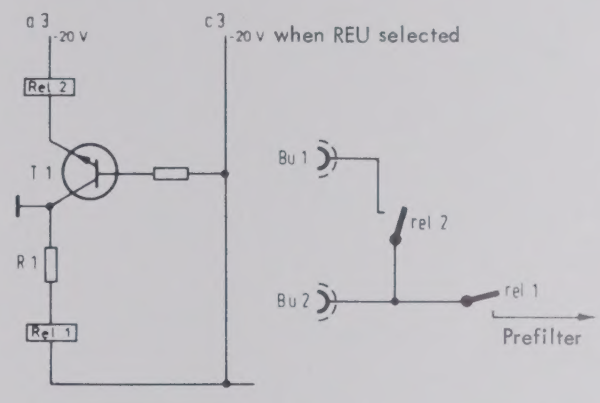


Fig. 10-24 Relay circuit at input of converter plug-in

When the plug-in is not connected, Bu 2 is connected to Bu 1 via Rel 2 for passing on the signal to the following plug-in.

For this purpose -20 V is connected to a3 and c3 is open. The base of T 1 connected via high impedance with resistors to ground. Transistor T 1 conducts and Rel 2 is energized.

When selected, further transmission to Bu 1 is interrupted by Rel 2 and the signal is passed to the filter via Rel 1. In this case both A 3 and C 3 have -20 V. The transistor cuts off and Rel 2 is de-energized. Re 1 is connected via R 1 to -20 V and is energized.

MP MASTER
MA33497

Wandel & Goltermann
Postbox 45·D-7412 Eningen u.A.·FRG·Tel.+497121 8441·Telex 0729-833